INTRODUCTION

Histology is a term ***derived*** from the Greek words ***"Histos"*** meaning tissue and ***"Logia"*** meaning We could think that Histology refers to the study of only tissues, but this is not so As you know Anatomy could be divided into that which is visible to the naked eye -cross Anatomy- and that which is seen only with the aid of a microscope -microscopic Anatomy-and this is our subject. **It** can be further classified into:

a- Cytology (study of cells);

c- Organology (study of organs).

AS the' *term "Histology"* was introduced by Bichat (18O2) for different ***groups*** of cells, it remains as the study of tissues *and* also covers all microscopic anatomy . Thus,***Histology***refers to study of cell, tissues and organ systems. it embraces the study of function as well the structure , and also provides the structure basis for the study of physiology . it is necessary a knowledge of the normal in order to study abnormal -Pathology- that deals with alterations of the structure and function of the body, its organs, tissues, and cells.

It could be stated that Histology was born when the microscope was developed. To study histology there are two important considerations to hear in mind:

1- The kind of microscope used, and

2- The preparation of the tissue

MICROSCOPY

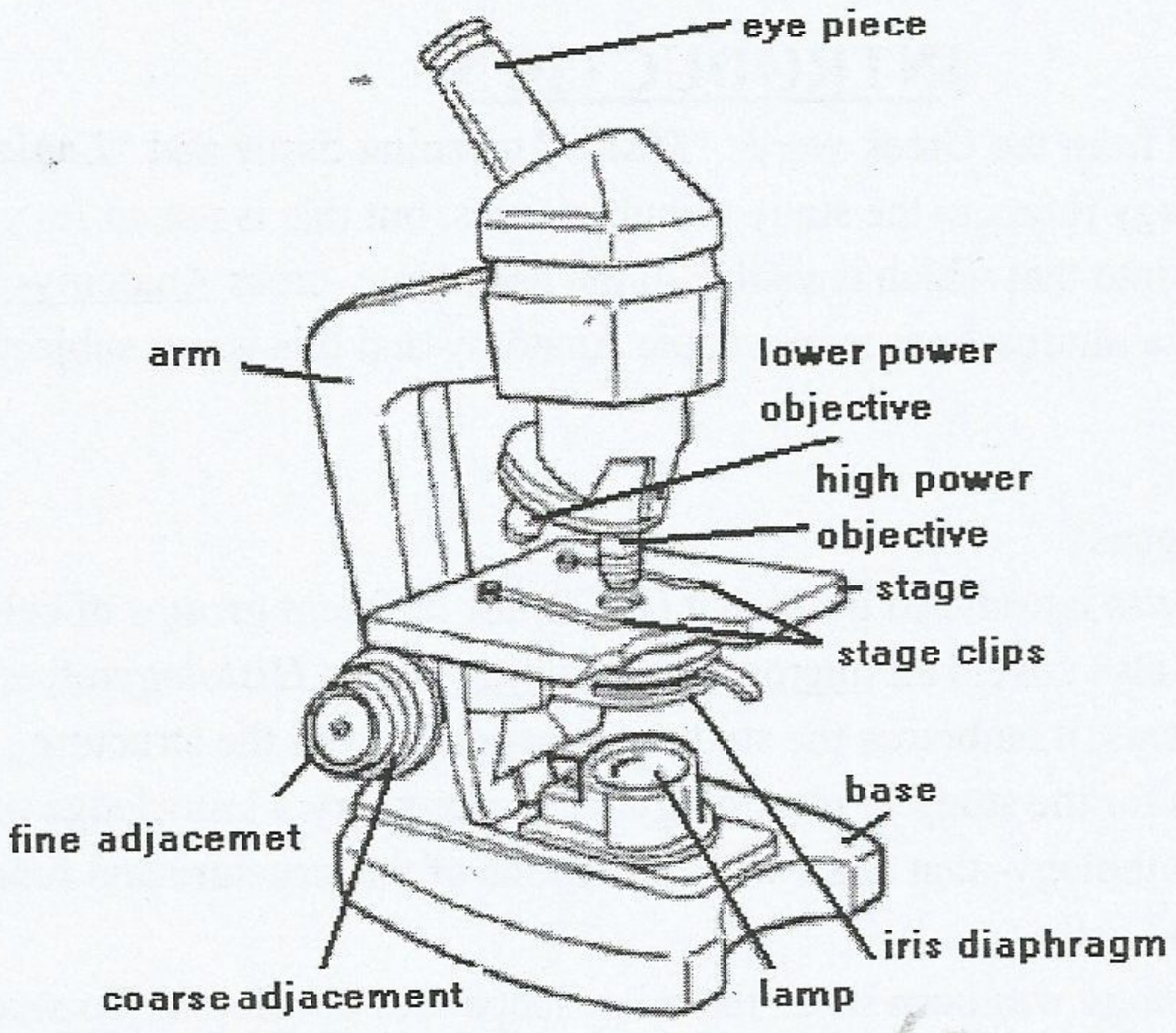
There are many types of microscopes. They are classified according to the type of light source used. in most general use is the optical microscope which uses visible light and is known as OM or LM. We will refer mainly to the LM and to the electron microscope –EM . which uses as illumination source a beam of high velocity electrons accelerated in a vacuum. There are many other types of microscope as you can see in any textbook. Now we will stop for a minute to have some facts cleared about the LM and the EM.

It is called "**resolution**" the "resolving power" of any microscope, that is. The capacity to clearly separate twopoints.

MTCROSCOPE	Resolution	MAGNIFICATION
Light	0.2μ	1500X
Electron	0.2mu	300,000 X

Recently it has been approved to replace those units by units related to the metric system. Since students will read both terminologies in books, they should be acquainted with both of them.

OLD TERMINOLOGY	NEW TERMINOLOGY
Micron (μ.)	Micrometer (μm)
Millmicron (mμ)	Nanometre (nm)
Amstrong unit (A°)	0.1 nm



Compound Microscope used for specialized study of the cells Include dark field microscope, phase contrast microscope and fluorescence microscope. Very minute subcellular structures can be studied with the help of electron microscope (TRANSMISSION and SCANNING)

The main instrument usedin the study of histology is bright field light microscope also called light microscope. Microscope presents an enlarged image of the specimen. Tissues and cells which cannot be seen with naked eye can be seen with the help of the microscope. The main components of a microscope are as follows:

A- OPTICAL PARTS:

1- Light source: Light is provided through a 6 volt 20 watt tungsten bulb. Bulbs with brighter illumination are used in advanced research microscopes. Reflected light from sun or tube light using reflecting mirror is still used but is not satisfactory.

2- Condenser: The parallel light rays emerging from the light source are converged onto the object with me help of a lens called condenser.

3- condenser: Light passes through the hole and illuminates the object under study.

4- Objective: Objective is a compound lens and is made of series of convex and concave lenses. It enlarges the image of the object and transmits to the eyepiece. The generally used magnifications of objective are 10x, 4Ox and 1OOx.

5- Eyepiece The eyepiece lens gathers the image transmitted from the objective and relays to the eye of the observer. It also further magnifies the image. Microscope is monocular if only one eyepiece is present and binocular if two eyepieces are attached for use for both the eyes simultaneously.

B- MECHANICAL PARTS

1- Mechanical stage: A rectangular stage with a large hole in the center and clips to grip the object or glass slide is placed above the condenser: Light passes through the hole and illuminates the object under study. 2. Arm. 3. Base. 4. revolver 5. coarse and fine adjustment6. draw (ocular) tube.

7. roak and pinion.

PREPARATION OF TISSUE:

Preparation of Tissues have to be suitable prepared for microscopic examination. There are two methods:

1. Direct observation of living cells.
2. Fixed or preserved dead cells.

Living tissues are usually more difficult to handle and are only available for a short period of time. In our practices, fixed and stained preparations of tissues, which are permanent, will be used.

PARAFFIN METHOD:

1.**Fixation:** A piece of tissue cut out of an animal and left without treatment will soon die and dry up. Even if it is kept wet, the cell enzymes will digest it. This process is called autolysis (self dissolution). It will also be susceptible for bacterial and fungal attack, a process called putrefaction. **Fixation** is therefore needed to prevent autolysis and putrefaction. It is also needed to make the tissue resistant to subsequent treatments, e.g. embedding, and to make it colorable by suitable dyes. The following is a list of chemicals used as fixatives, either alone or mixed in specific proportions. Formalin (10 % solution of the formaldehyde gas in water for 24 hours) SUZA,ZINKER and bouins

2 — Wash in running tap water for several hours. Three or four hours are enough if formalin is the fixative used.

3 — **Dehydrate**, (i.e. remove water or **Dehydration**) in ascending grades of alcohols (70 %, 90 %, 96 % then 100 %). The time of dehydration depends on the size of the piece of tissue. For a piece 5 mm thick 2 hrs in each change of alcohol will be enough. to prevent tissue shrinkages

4 — Alcohol is then removed by immersing in xylol or benzene. This step is called **Clearing**, since the tissue becomes translucent. 1 hr is sufficient for clearing.

5 — The tissue is **impregnated** with two or three changes of molten paraffin then embedded in it in the form of a block. The time of impregnation is 2 - 3 hours.

6 — **Sections** are cut from the paraffin block using an instrument called the **Microtome**. The ideal thickness of sections is between 8 and 10 microns (μ).

7 — **Mounting**: Sections are spread by floating them over warm water, (40 - 45 °C). Each section is picked up by a clean glass slide coated with a very thin film of egg albumin. The slides are then put in a warm (40 °C) oven and left to dry overnight. As the sections dry, they are stuck to the slides by the albumin film.

8___ **Staining** the most used stain is combination of Haematoxylin (H) and eosin (E).

Result: Nuclei are stained blue with haematoxylin while the cytoplasm is stained red with eosin. Generally speaking, any basophilic structure in the cell will stain with haematoxylin and any acidophilic structure will stain with eosin.

9- **Mounting**

Definition: a basophilic structure is one which has the affinity for basic dyes because of its acidic nature. For e.g. the nucleus is rich with an acid known as DNA (deoxyribonucleic acid) and therefore is basophilic. The acidophilic structure, on the other hand, is one which stairs with acidic dyes because it contains a base (like a basic protein) as in the case of the cytoplasm of some cells.

All the student-sections are stained with H & E unless otherwise stated

THE CELL

*Definition: It is structural and functional unit of all living tissues (Plants and animals). Cells have different shapes and size.
*Size of the cell: Lymphocyte is one of the smallest cells (6um) While fat and ova are the largest cells (160 um).
*Shape of cell: some cells rounded, other oval, flat, cubical or columnar.

Composition:

1- Major component of cell is water(75%)
2- Numerous inorganic components:
a- Chief intracellular cation is K+.
b- Chief intracellular anions are HCO3-, HPO4-2, SO4-2.
3- Macromolecules suspended in the basic aqueous soup: Nucleic acids ,DNA and RNA
4- Proteins :Made up of amino acids. May be conjugated with lipids, sugars or nucleic acids.
5- Lipids :May be conjugated with other macromolecules.Important constituent of membranes.
6- Carbohydrates: Polysaccharides,Polysaccharide-protein complexes.Glycoproteins.Glycolipids.

The **protoplasm** is subdivided into two compartments in the body cells, the cytoplasm and the nucleus. The cytoplasm is a “colloidal solution" and within it are the cytoplasmic bodies, “organelles” which are living structural components, and “inclusions” which are non-living accumulations. The nucleus contains the genetic information necessary for many cellular activities, the karyoplasms and the nucleolus.

Properties of protoplasm:.

The protoplasm properties indicate the functions of the cells, and some are more developed by particular type of cells. They are the following:
1. IRRITABILITY is the capacity to respond to a stimulus and is the expression of life itself
2. CONDUCTIVTTV is the property to transmit a wave of excitation. It is developed at nerve and muscle cells.
3-CONTRACTILITY is the property of Changing shape. it is highly developed in muscle cells.
4. RESPIRATION: is the process whereby cells interact with nutrients and oxygen to produce energy, waste products, carbon dioxide and water.
5.ABSORBTION: is the capacity that the cell has to let get in substances from the environment.
6. SECRETION is theprocess by which a cell delivers useful material externally.
7. EXCRETION is the elimination from the cell of waste products of metabolism.
C. GROWTH is the increase in the size of cells as a result from the increase in the amount of protoplasm. There is a maximum size for each cell type Beyond themaximum size, usually cell division occurs.

Structural Organization

Cytoplasm

Cytoplasmic matrix(Cytosol, Ground Substance). Basic structureless component of the cytoplasm. Consists of large molecules of protein, soluble enzymes, mineral salts, and other absorbed soluble substances.

Organelles and inclusions suspended in the cytoplasmic matrix.

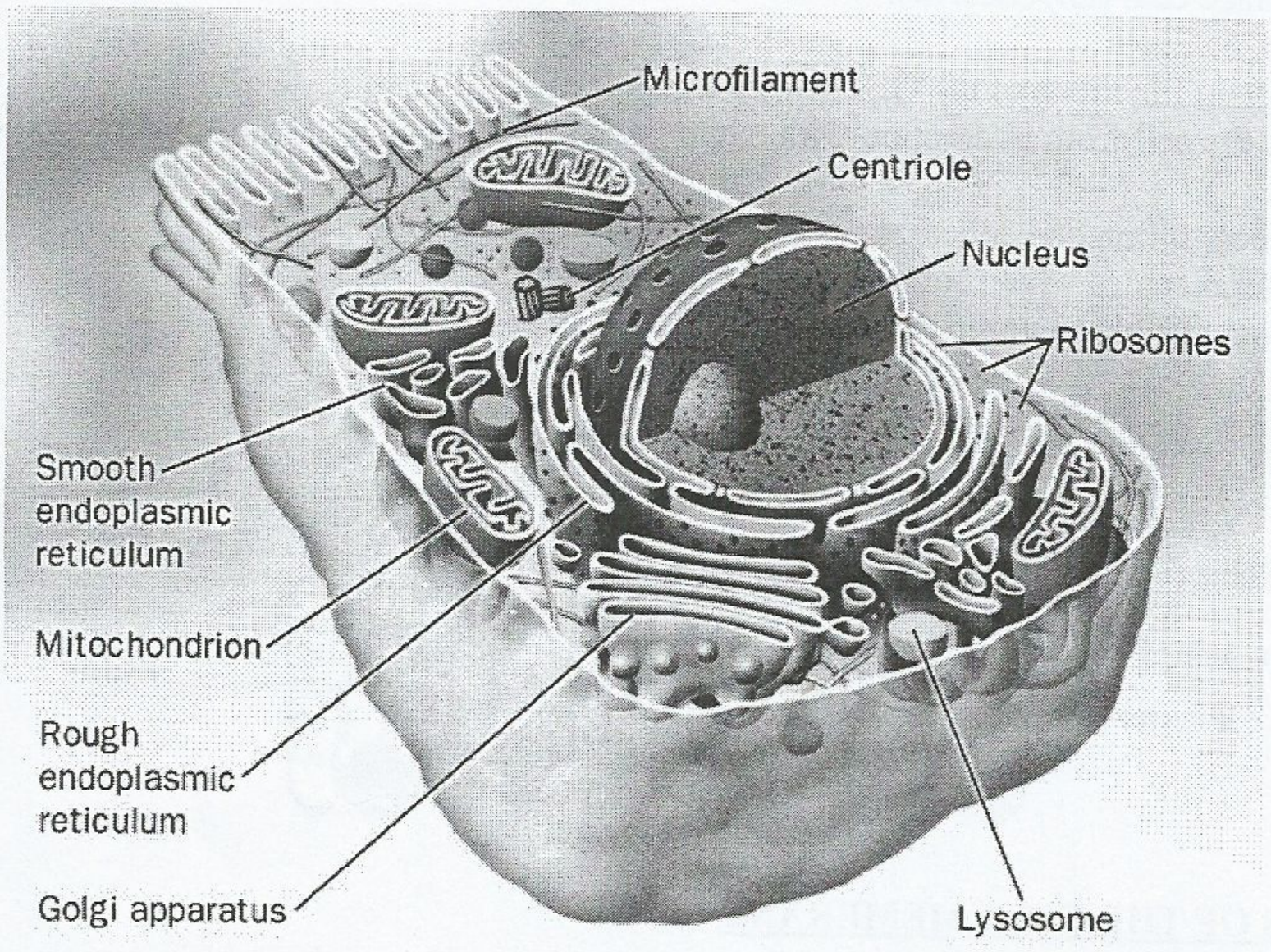
Cytoplasmic Organelles: they are differentiated structures, essential for vital processes of the cell(respiration, digestion, secretion, excretion).

Inclusions: they are not essential for vitality of cells. They may be present **Cytoplasmic Organelles** :They are membranous and non-membranous

Cytoplasmic Organelles

A- Membranous Organelles:

1- Cell membrane (plasma membrane)
2- Mitochondria.
3- Endoplasmic reticulum (rough & smooth)
4- Golgi apparatus (Golgi body or Golgi complex)
5- Lysosomes
6- Peroxisomes(microbodies)



B – NON- Membranous Organelles:

1- Ribosomes.
2- Centrioles
3- Cytoskeleton(Microtubules And Filaments Structures).

A- Membranous Organelles:

1-Cell membrane(plasma membrane, plasmalemma):

Is very difficult to be seen by light microscope. It is an ultrathin membrane that surrounds the cell.
By E.M: appears as two dark layers, separated by a light one, (trilamellar membrane or unit membrane)
The molecular biology of the cell membrane: is composed of lipid bilayer associated with proteins and carbohydrates, giving together a mosaic appearance.

a) Phospholipids molecules arranged into 2 layers (bilipid layer). Each molecule has a polar & a non-polar end.

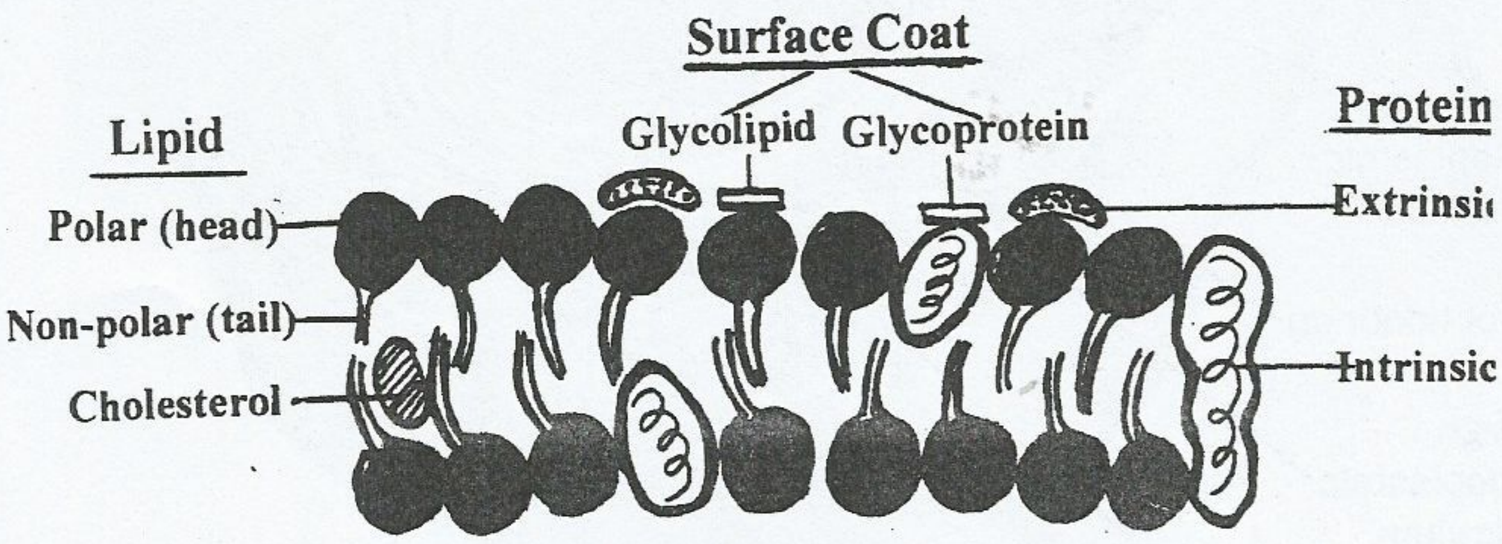
* The polar end (head) is hydrophilic and directed outwards, so the heads are found on the outer and the inner (Cytoplasmic) surfaces of the cell membrane.

* The non-polar end (tail) is hydrophobic and directed inwards where the tails of the two layers interact with each other forming a stable centre for the cell membrane.
b) Cholesterol molecules are incorporated in the hydrophobic regions of the cell membrane.

b) Protein Component: It consists of:
a) Extrinsic protein: It is formed of loosely attached protein molecules, found on both surfaces of the cell membrane.
b) Intrinsic protein: It consists of small or large protein molecules, either floating in the bilipid layer or fixed by certain cytoskeletal components.
c) Carbohydrate Component: It consists of short chains of polysaccharides conjugated with either proteins or lipids of the external surface of the cell membrane (glycoproteins and glycolipids), forming the surface coat (Glycocalyx).

Surface Coat:

The most important functions of the Glycocalyx are:
a- Protection of the cell from interaction with inappropriate proteins and also from chemical or physical injury.
b- Cell to cell recognition and adhesion.
c- Have certain molecules which act as specific receptor.
d- In RBC, it contains blood group antigens.



FUNCTIONS OF THE CELL MEMBRANE

Is a specific, selective process utilizing energy and comprises endocytosis and Exocytosis

Endocytosis includes:

A - Phagocytosis (cell eating).
B - Pinocytosis (cell drinking).
C - Receptor Mediated pinocytosis

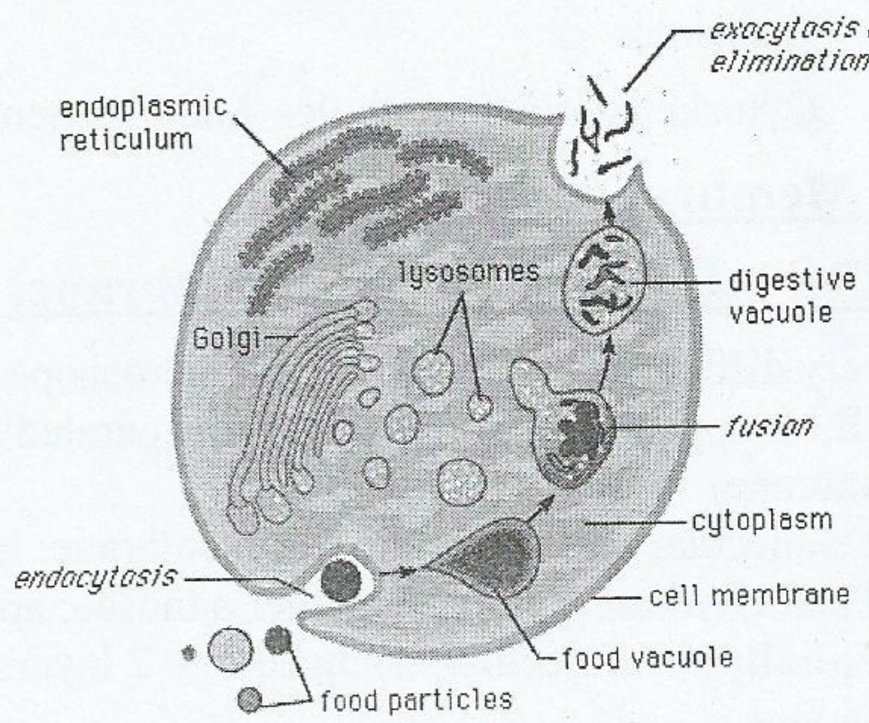
A- Phagocytosis:

It is the processes of intake of solid particles from the environment by extending processes that envelope and draws the particle into cytoplasm.

B- Pinocytosis:

The cell membrane invaginates to produce a deep, narrow pit.
The membrane near the surface of this pit then fuses, and small vacuole or pinocytic vesicle containing the extra- cellular fluid is pinched off and enters the cell.

C-Receptor- mediate endocytosis:



In receptor- mediate endocytosis, the interaction of the very specific molecules in the extracellular environment with specific membrane receptor proteins causes the membrane to invaginate, fuse, and pinch off to form a vesicle.

SPECILIZITIONS OF THE CELL MEMBRANE

1-Modification at the free surface of the cell includes microvillus, Cilia, sterocilli, and flagella.
2-Modification at the lateral surface of the cell includes junctional complexes at Epithelium tissue and membrane inter-digitations.
3- Modification at the basal surface of the cell includes basement membrane and basal in folding.

2- Endoplasmic reticulum

Flattened, rounded or tubular vesicles or cisternae anastomosing with one another, and continued frequently with the nuclear envelope.

Granular(rough) ERstudied with ribosomes, usually arranged in the form of flattened cisternae stacked in parallel, are abundant in secretory cells with protein synthesis..

A granular(smooth) ER lacks ribosomes, usually vesicles or tubules of membrane-bound, concerned with steroid synthesis. Drug detoxification occurs in hepatocyte. synthesis and storage of lipids and cholesterol. Muscle contraction and relaxation ,by acting as calcium pump

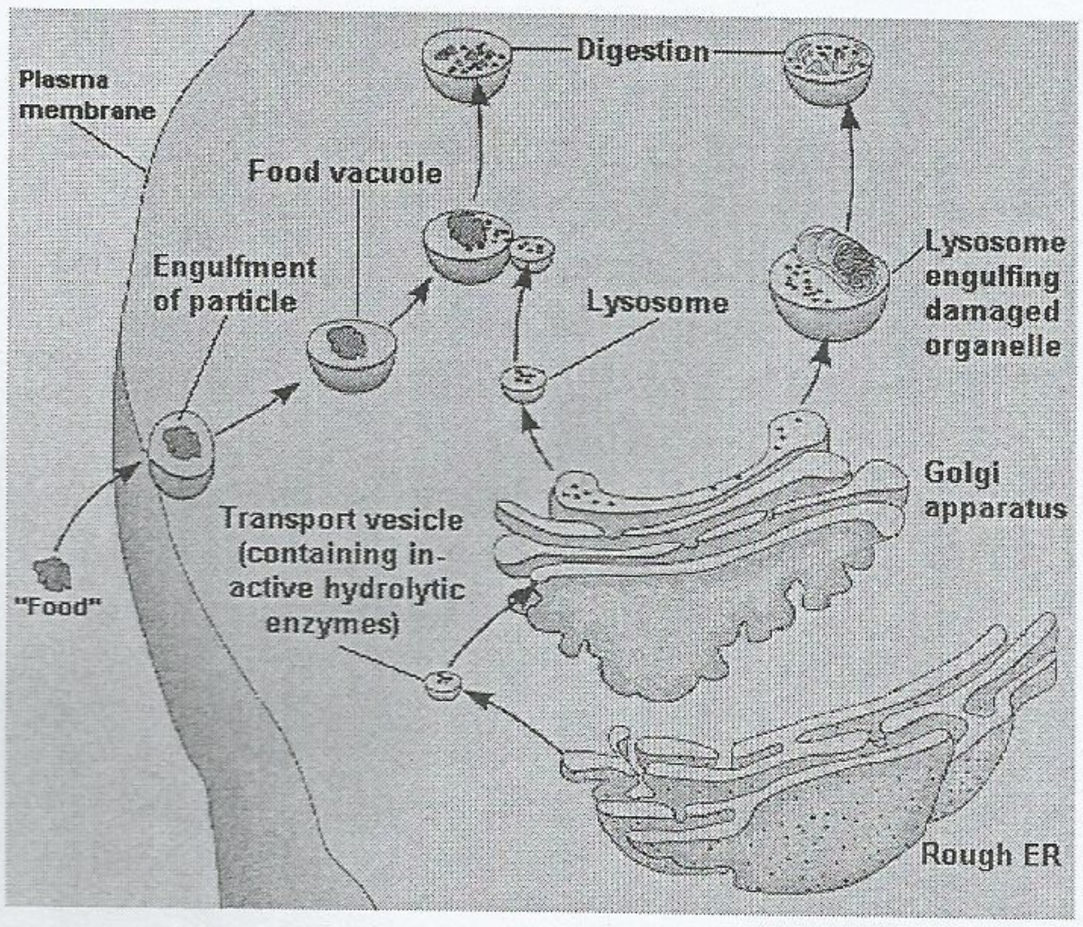
Golgi apparatus

A group of piled up flat saccules or cisternae arranged in parallel array, located in juxtanuclear area. Convex surface (forming face), fenestrated, flattened cisternae with transfer vesicles derived from ER.
Concave surface (maturing face), dilated cisternae associated with condensing vacuoles or secretory granules.

- Active role in packing of protein-rich materials.
- Conjugation of sugars and proteins in glycoproteins

Lysosomes

Membrane-bound vesicles 0.2-0.5μ in diameter, containing hydrolytic enzymes.
Active intracellular digestion for ingested materials (Phagocytosis) or normal cellular organelles (autophagy)
Synthesized in RER, transferred and packed in Golgi apparatus as primary lysosomes containing inactive enzymes.
Secondary lysosomes, vacuolar structure engaged in current or past digestive activity. **TYPES:**
1-Autophagic lysosomes: formed by fusion of primary lysosomes with a dead organelle as mitochondria.
2- heterophagic vacuoles: formed by fusion of primary lysosomes phagocytic vesicles (phagosome) ,containing exogenous substance, bacteria.



3-multivesicular bodies: formed by fusion of primary lysosomes with pinocytic vesicles.
4-residual bodies: are secondary lysosomes which contain indigestible materials, that are discharged by exocytosis.

Mitochondria:

LM: They appear as rods, granules or filaments, after staining with Iron H or Janus green.
- They vary in number and size according to the function of the cell Mitochondria

EM:

- Each mitochondrion is surrounded by 2 membranes. The outer membrane is smooth, while the inner one forms incomplete and alternating shelves (cristae). Cristae increase the surface area for deposition of enzymes that function in oxidative phosphorylation.
- The cavity is filled with mitochondrial matrix, which contains:
  - Enzymes of Krebs cycle and fatty acids oxidation.
  - Phospho-lipo-proteins (matrix granules) that bind calcium (Ca) and magnesium (Mg).
  - Contains its own genetic apparatus (DNA and RNA).

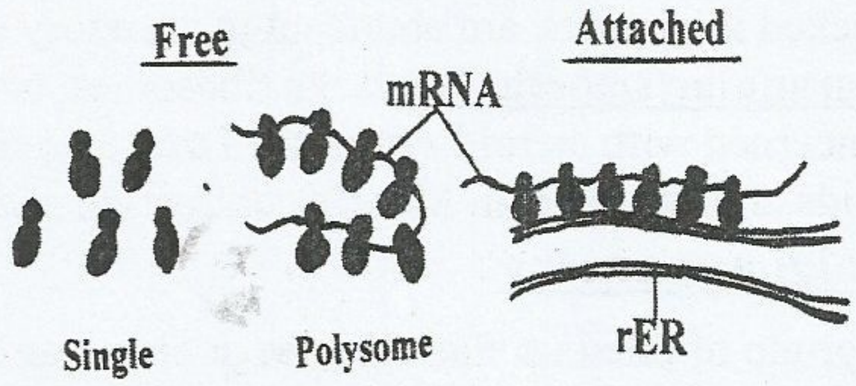
Functions:

1- Cell respiration and production of adenosine triphosphate (ATP), the primary source of energy for the cell. That is why they are called the power-house of the cell.

2- They can form proteins for themselves and undergo self replication.

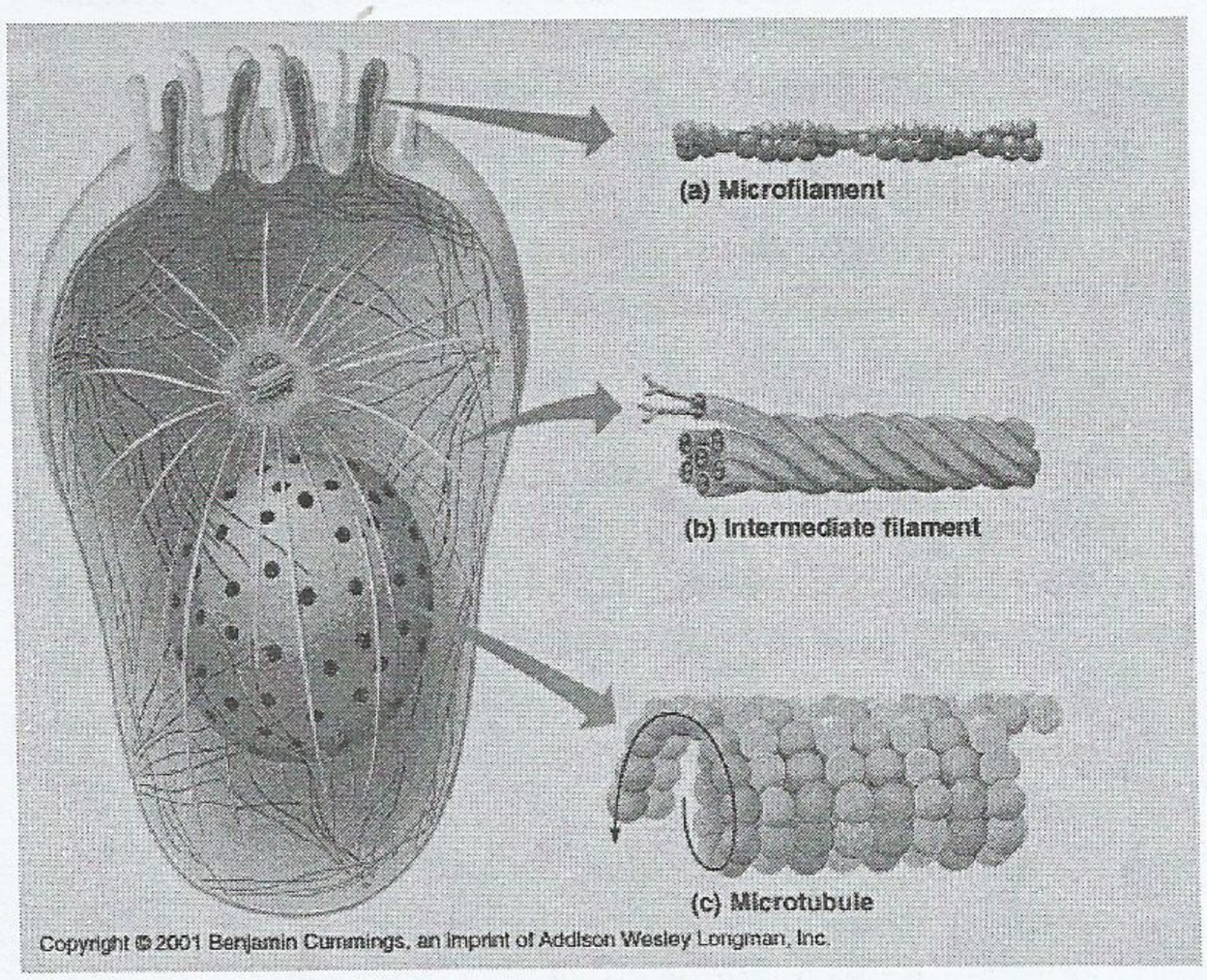
B – NON- Membranous Organelles

Ribosomes :



Small electron dense particles, 15-20nm in diameter.
RNA(60%) and protein(40%) responsible for the basophilia, known as basophilic body, ergastoplasm, Nissl body.
E/M: Appear as electron dense granules, which may be
— Free, either singly or in groups, connected together by a messenger RNA (mRNA), to form clusters or spiral chains (polyribosomes or polysomes).
— Attached, arranged on the membrane surface of the rough endoplasmic reticulum.
Free ribosomes synthesized the protein for intracellular use,
attached ribosomes associated with synthesis of protein for export.

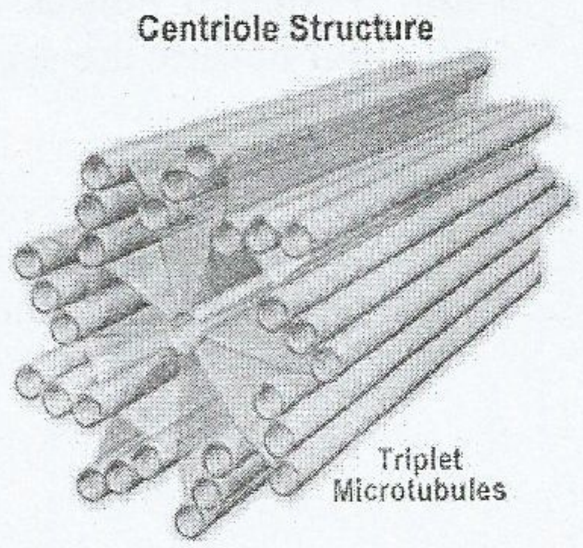
Microtubles



Rod- like or pipe-like structures 24nm in diameter with the wall 5nm thick, several micrometer long.
Composed of 13 protofilaments, which made up of protein subunit (tubulin dimers).
·Appear and disappear by polymerization and depolymerization of a pool of these subunit.
Growth blocked by colchicines (antimitotic alkaloid that bind tubulin).
Function: - Rigid nature - cytoskeleton, intracellular transport.
Provide the basis for Centrioles, cilia and mitotic spindle fibers.

Centrioles (cell center, centrospheres)

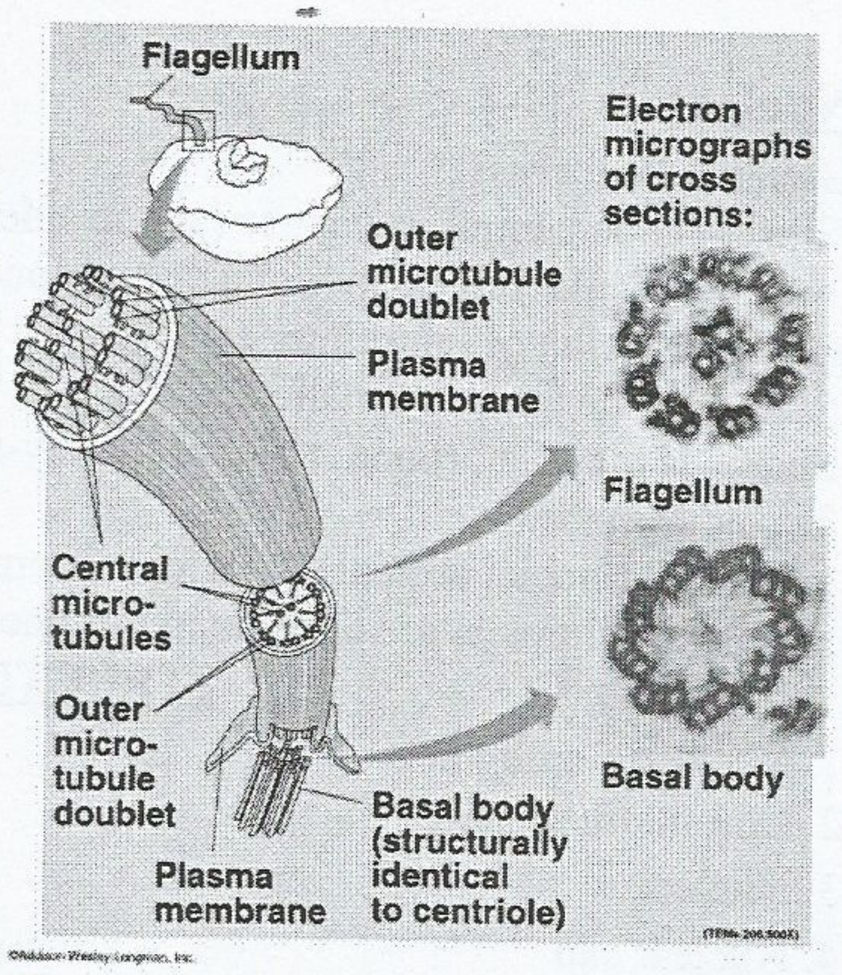
Short rods located in special region of cytoplasm adjacent to the nucleus called centrosome.
Ocular in pairs(diplosome), long axes are at right angles to each other.
Self-duplicate in S period and move to opposite sides during mitosis.
Hollow cylinder 150nm in diameter and 300-500nm in length in EM.
Composed of 9 sets of three microtubules, triplets, in the characteristic pinwheel arrangement.



Pericentriolar bodies represent nucleation centers for microtubule formation.

Functions: 1- Initiation of cell division and spindle formation.

2- Formation of cilia and flagella.



Cilia:

L/M: Appear as hair-like striations on the free surface of the cells.

E/M: Each cilium is formed of shaft, basal body and rootlets:

— The shaft is formed of 2 singlets in the centre of 9 doublets, all surrounded by cell membrane.

— The basal body, has the same structure as centriole (9 triplets).

— The rootiets microtubules extend from basal body to fix the cilium in the cytoplasm

Function: Help movement of particles or fluids in one direction, e.g. in respiratory tract.

Filaments:

Microfilaments

Types of Cytoplasmic filaments: There are three categories of Cytoplasmic filaments:

I- Actin filaments (microfilaments):

- They are the smallest in size, 7nm in diameter.
- They consist mainly of a protein called actin.
- They are present mainly in the striated muscle cells myocytcs) as contractile element.
- They play an important role in cell division as they form the contractile ring during the telophase.
- They are present also in the Core of microvilli, terminal web and blood platelets.

II- Thick or Myosin filaments:

- They are thicker than actin filaments, 15 nrn in diameter
- They are formed of a protein, myosin.
- They are present mainly in the striated muscle cells as a contractile element, in the form of thick filaments.
- They are present also in rnicrovilli, terminal web and blood platelets

Actin and myosin filaments may he called myofilaments.

III- Intermediate filaments

They are 10 nm in diameter, intermediate in size between thin(actin) and thick filaments(myosin) .

They include the following filaments: -

I- Tonofilaments (Keratin filaments) of the epithelium of skin.

ii- Neurofilaments of nerve cells.

iii- Desmin filaments of muscles specially smooth muscle.

iv- Vementin filaments of mesenchyrnal cells as fibroblasts.

Cytoplasmic inclusion

Usually transitory components of cytoplasm, mainly of accumulated metabolites or deposits of varied nature.

1- Glycogen in the liver cells, usually granular, electron-dense particle.

2- Lipid droplets in adipose tissue, adrenal cortex and liver cell.

3- Protein in glandular cells as secretory granules.

4- Pigment: endogenous: melanin in epidermal and retinal cells lipofuscin(pigment of aging).exogenous: e.g.: dust, tattoo marks, carotenes

Nucleus

General Features:

Site: May be central, eccentric (at one side) or peripheral.

Number: Cells may be mononucleated (one nucleus), binucleated (2 nuclei, as in liver cells) or multinucleated (many nuclei, as in osteoclasts).

Size: May be large or small.

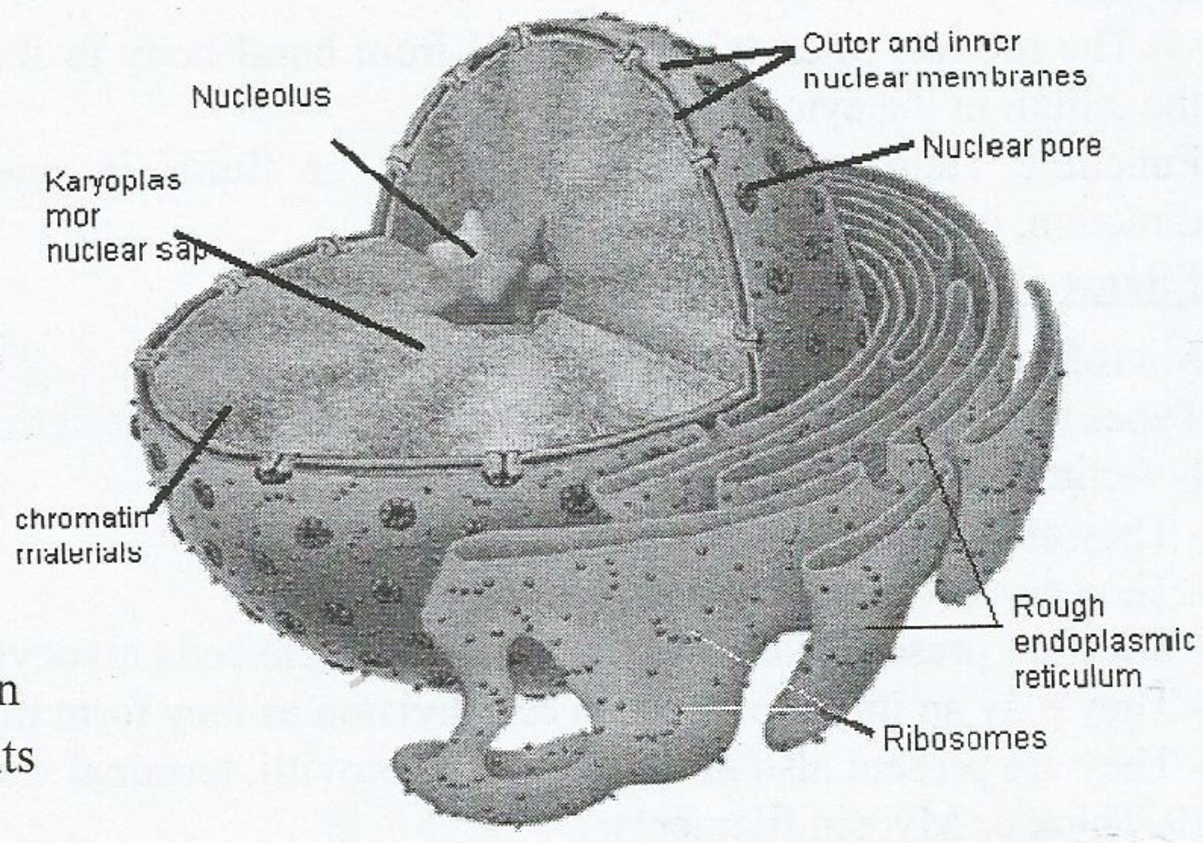
Shape: It may flat, round, oval, or kidney-shaped. It may be lobulated, as inneutrophils.

Types: May be:

- Vesicular nuclei are pale with few chromatin, as in nerve cells.
- Condensed nuclei are dark, as in lymphocytes.

STRUCTURE OF THE NUCLEUS

1. Nuclear membrane.
2. Chromatin material
3. Nucleolus
4. Nuclear sap



1- Nuclear Membrane (Envelope)

LM: Appears as a dark blue line.

EM: It appears as a double walled membrane with many pores.

a) Outer membranous layer: continuous with endoplasmic reticulum, even with ribosomes on its surface.

b) Inner membranous layer: with chromatin granules (peripheral chromatin), attached to its inner surface.

c) Nuclear pores, are circular openings in the nuclear membrane. The inner and outer membranes fuse together at the edge of each pore and the opening is covered by a diaphragm. At site of each pore, chromatin material (peripheral chromatin) is deficient. Pores provide communication between nucleus and cytoplasm.

2. Chromatin Material

_ Chromatin material is formed mainly of DNA, which contains the code of genetic information.

LM: Chromatin appears as **basophilic granules**, which may be coarse or fine.

E/M:

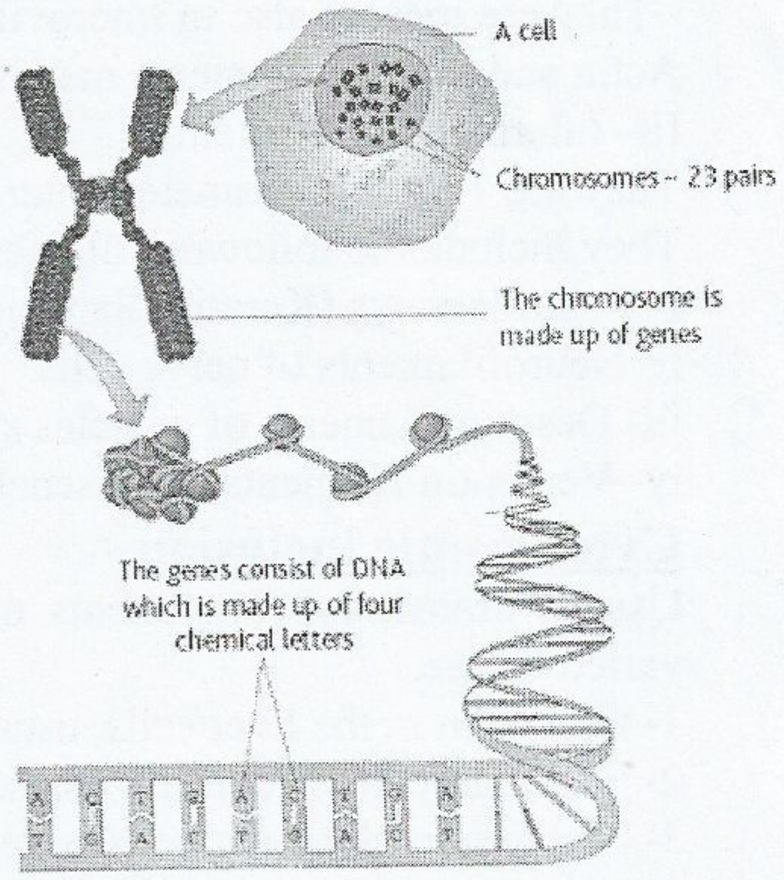
_ **Euochromatin** (extended or active). It appears pale and formed of thin uncoiled threads.

_ **Heterochromatin** (condensed or inactive). It is dark and distributed as:

a) Peripheral chromatin, attached to the inner wall of the nuclear membrane.

b) Nucleolus-associated chromatin, around nucleolus.

C) Chromatin islands, scattered in the nucleus.



Functions:

— Carries genetic information.

— Directs protein synthesis in the cytoplasm via the formation of the 3 types of RNA (ribosomal rRNA, messenger mRNA, and transfer tRNA).

3. Nucleolus

LM:— It is an almost spherical darkly stained mass (basophilic).

— There is one or more nucleoli in each nucleus.

EM:Showing dark material permeated by light spaces. The dark material consists of:

— **Nucleolus-associated chromatin**, the DNA material that forms the nucleolar organizer region of the chromosome.

— **Fibrillar component**, small fibrils representing the early stage in the formation ribosomes (rRNA) by the DNA (nucleolar organizer).

— **Granular component,** large particles, represent advanced stages in the formation ribosomes (rRNA).

Function:

It is Involved in formation of ribosomal RNA (rRNA), which is responsible for protein synthesis in cytoplasm.

N.B.: Protein forming cells, have a well developed nucleolus and might have more than one.

4. Nuclear Sap

It is a colloidal clear medium in which all the contents of the nucleus are embedded. . Nuclear sap contains lipoproteins, ions and enzymes.

Function: It provides a medium for the movement of the three types of ribonucleic acid (ribosomal, messenger and transfer RNA) which are formed in the nucleus and pass through the pores to carry their function (protein synthesis) in the cytoplasm.

FUNCTIONS OF THE NUCLEUS

1- It is important for the vitality and division of the cell.

2- It is the site of storage of **genetic information**.

3- It is the site of formation of the **three types of RNA**.

THE LIFE CYCLE OF THE CELL

So the cell cycle is divided in two basic parts:

1-Mitosis (cell division).

2-Interphase (interval between the divisions).

Interphase is subdivided into three stages:

1-First gap stage (G1).(**preduplication)**

1- Synthesis stage (S stage **or duplication phase)**

2- Second gap stage or **G2 (post duplication) phase**

2-MITOSIS (Indirect cell division

Stages of the mitosis:

1-Prophase

2-Metaphase: (Met=Between):

3-Anaphase stage (Ana=Apart =Toward

4-Telophase stage (Telo=End)

TISSUES OF THE BODY

Body organs are made of 4 main tissues:

1- **Epithelial tissue:** simple, stratified, glandular; neuro-epithelium & myoepithelium.
2- **Connective tissue: proper C.T.,** cartilage ; bone and blood
3- **Muscular tissue: skeletal,** cardiac & smooth muscles.
4- **Nervous tissue:** neurons (nerve cells & fibres), neuroglia & nerve endings.

EPITHELIAL TISSUE

GENERAL CHARACTERISTICS:

1- It is formed of crowded cells with very little intercellular substance in-between.
2- It is not penetrated by blood or lymph vessels (avascular), however, nerve fibres penetrate between epithelial cells.
3- It is separated from the underlying connective tissue, by a basement membrane, may be clear or non-clear.
4- It has a high power of regeneration.
5- It covers & lines surfaces, some form glands or it may be modified to act as a receptor.
6- It may be ectodermal (as skin), mesodermal (as serous membranes) or endodermal (as GIT) in origin.

TYPES OF EPITHELIUM: simple (formed of one layer), stratified (many layers glandular (secretory), neuroepithelium (act as receptor) & myoepithelium (contractile).

Functions of the epithelium:

1-Protective functions of epithelium include protection against:
(a) mechanical damage
(b) loss of fluids -waterproof
(c) invasion of foreign bodies
2-Thei glandular secretions of the body by glands (exocrine and endocrine) are mainly a function of specialized epithelium.
3-Some epithelia are modified for sensory reception including recognition sensory stimuli such as pain or chemoreceptor (such as taste buds)

Membranous epithelium

classified according to three morphological characteristics
1-The number of the cell layers:
A simple epithelium: contains only one layer of cells.
B) Stratified epithelium: contains more than 2 layers of cells. ‘
2- The shape of the cells:
a) Squamous epithelium: These are made of flattened cells.
4 b) cuboidal epithelium.
c) Columnar epithelium
3-The presence of surface specializations : such cilia, Microvilli and keratin.

I. SIMPLE EPITHELIUM

1- simple squamous epithelium:

It is formed of one layer of flat cells with flattened

nuclei.

Sites:

>>Endothelium, lining heart & blood vessels (CVS).

>> Mesothelium of serous membranes (as pleura).

>>Alveoli of lungs.

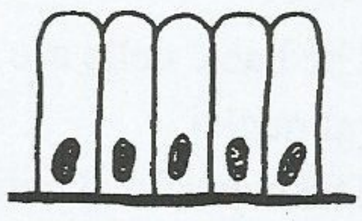
>> Bowman's capsule of kidney.

II. 2- simple cubical epithelium:

It is formed of one layer of cubical cells with central rounded nuclei. It lines thyroid follicles, convoluted tubules of kidney and medium-sized ducts of glands.

Functions: lining, Secretion, excretion, covering

3. simple columnar Epithelium



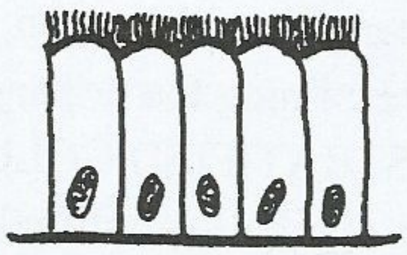
It is formed of one layer of tall columnar cells with basal oval nuclei. Subdivided into ciliated and nonciliated Simple Columnar is present in the following areas:

a) In the stomach, simple columnar cells secretes mucin, so the cells have clear cytoplasm.

b) In the intestine, they have dark cytoplasm and the surface is covered with microvilli for absorption processes.

-These microvilli are finger-like processes of the cytoplasm covered with membrane and are composed of microfilaments.

- And associated with goblet cells.



4- simpe columnar epithelium

It is formed of simple columnar cells with basal oval nuclei, the free surfaces of these cells are covered with cilia. It is present in the bronchus of the lung

5 - pseudostratified epithelium

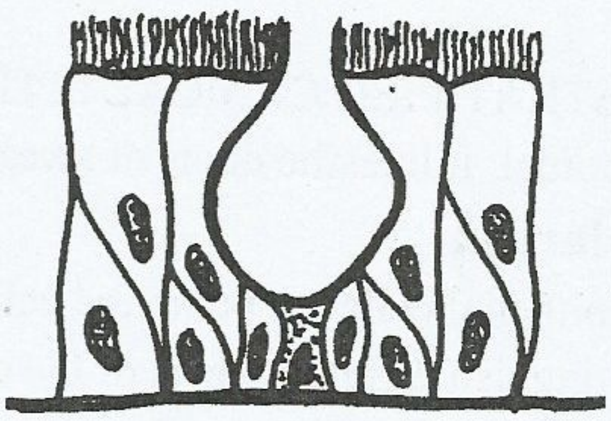
It is a simple type of epithelium formed of one layer of columnar cells resting on a clear wavy basement membrane.

- formed of the cell membrane of the Ciliated With Goblet Cells ,basal cells.

- Thecolumnar cells are irregularly arranged, therefore their nuclei are, arranged at different levels forming false raw

- All the cells reach the basement membrane but some of them may fail to reach the surface.

- The surface may be ciliated or non-ciliated. Cilia may be motile or non mot



Stratified epithelium

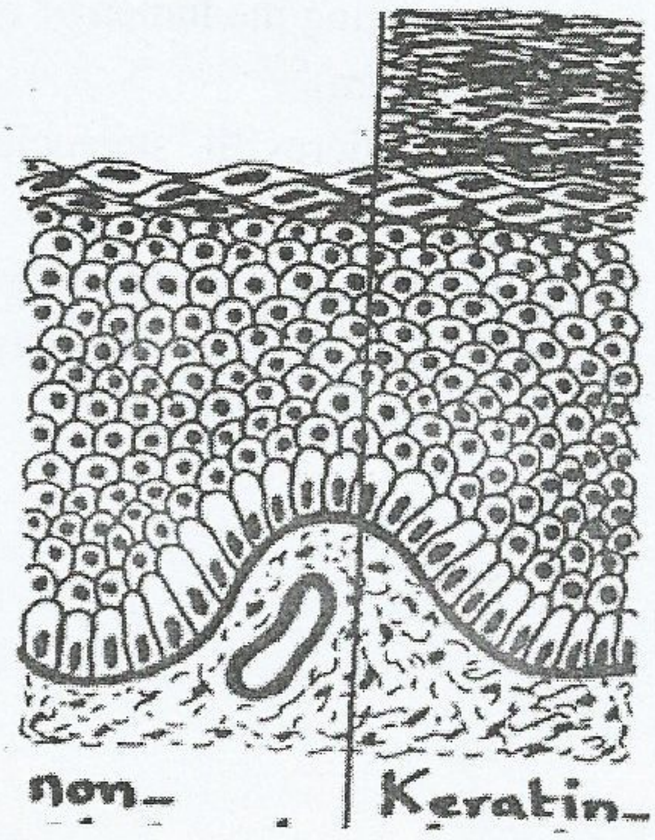
is formed if many layers of cells (3 or more layers).

Types of Stratified Epithelium: The stratified epithelium is named according the most superficial cells, So We have the following four types:

1- Stratified squamous Epithelium (the superficial cells are squamous).

2- Stratified columnar epithelium (the superficial cells are columnar).

3- Stratified cuboidal epithelium : (the superficial cells are cuboidal).



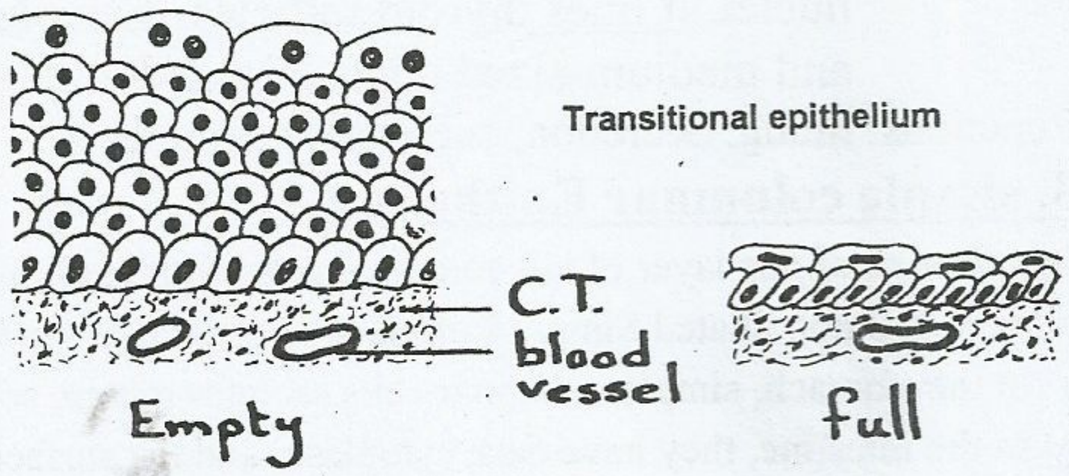
4- Transitional epithelium.

1- Stratified squamous Epithelium: Stratified squamous epithelium when the cells nearestto the external environment are flattened. The cells nearest the base are more columnaror cuboidal , whereas the cells nearer to the surface are flatter

The stratified epithelium of the skin (epidermis) has a layer of keratin and is called a keratinized (or dry) epithelium. While Stratified squamous epithelium is non keratinized, found in the esophagus ,oral cavity.

1- TRANSITIONAL EPITHELIUM:

- It consists of 4-8 layers of cells.
- The basement membrane is indistinct (not clear).
- The basal cells are short columnar with basal oval nuclei.
- The superficial cells are large with convex free surfaces and may be binucleated.
- The intermediate cells are polygonal with central rounded nuclei.



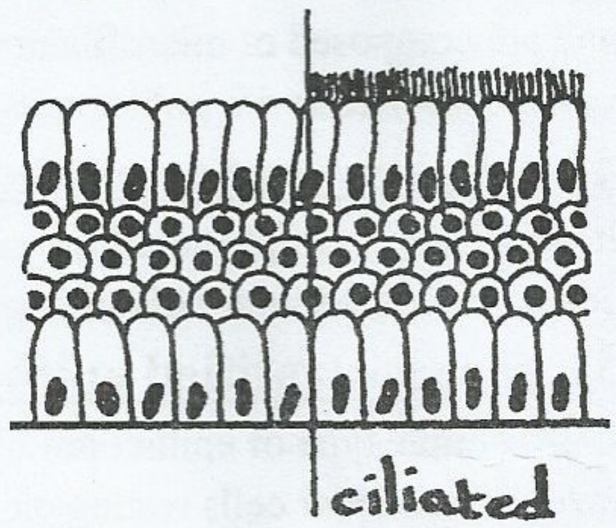
- The intercellular spaces contain a mucoid-like substance, which allows gliding of cells, so during distension of the organ, the epithelium is made of 2-3 layers.

Sites: lining the urinary tract: pelvis of ureter, ureter, urinary bladder

3- STRATIFIED COLUMNAR EPITHELIUM:

It is similar to stratified squamous epithelium, but the surface cells are columnar. It may be:

- Non-ciliated: in cavernous (penile) male urethra
- Ciliated: soft palate.



4- STRATIFIED CUBICAL EPITHELIUM: Its superficial cells are cuboidal. It linesthe ducts of sweat glands.

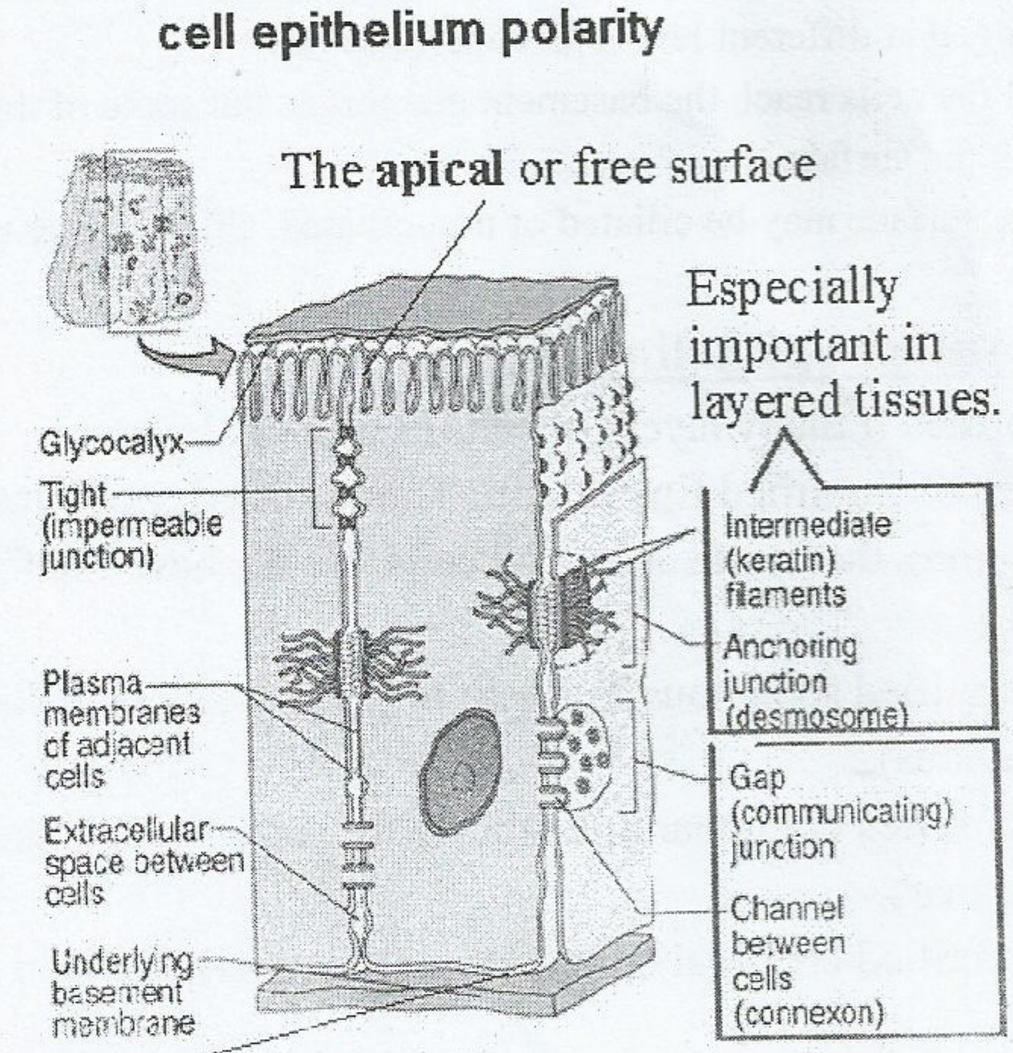
Polarity:

• Epithelial cells are polarized cells and we can distinguish different areas of the cells (apical, basal, lateral) with specific structural modifications (unlike other tissues, where structural polarity is not found)

I- Specific structures found on the ,the free surface facing the lumen or external environment)

include: Microvilli "stereocilia" cilia or flagella.

II- The lateral surfaces: between adjacent epithe1ial cells) typically have “junctional complexes” including:



The basal or attached surface, usually with an underlying connective tissue.

Gap junctions are found in epithelia, smooth and cardiac muscle, nerve, and certain connective tissues.

1- tight junction enabling the organism to maintain the Integrity of its internal environment.
2- adhering junctions (desmosomes) promoting adhesion and reinforcing the structural integrity and sites for stress fibers
3- communicating junctions (gap junctions or nexuses '(which allow the exchange of nutrients, ions, signals between adjacent cells
III- Epithelial cells are separated from the underlying connective tissue by a basal lamina 'secreted by the cells themselves. The plasmalemma at the base of epithelial cells, especially those with metabolic function (ion-transporting epithelia) may be modified by having marked invaginations to increase the surface area.

GLANDS

The Major Types of Glands: The two types are based secretion.
Exocrine Glands : that secrete their products onto the apical (or epithelia) surfacedirectly or via epithelial ducts or tubes that are connected to the apical surface. These exocrine glands are composed ofhighly specialized epithelial cells and thus are classified as glandular epithelia.
Endocrine Glands: that release their products basally, so the secretion goes through the basal lamina, moves into the underlying connective tissue, and enters the vascular system. Endocrine glands lack a duct system.
There are several ways of classification of glandular epithelium:

1- According to presence or absence of ducts:

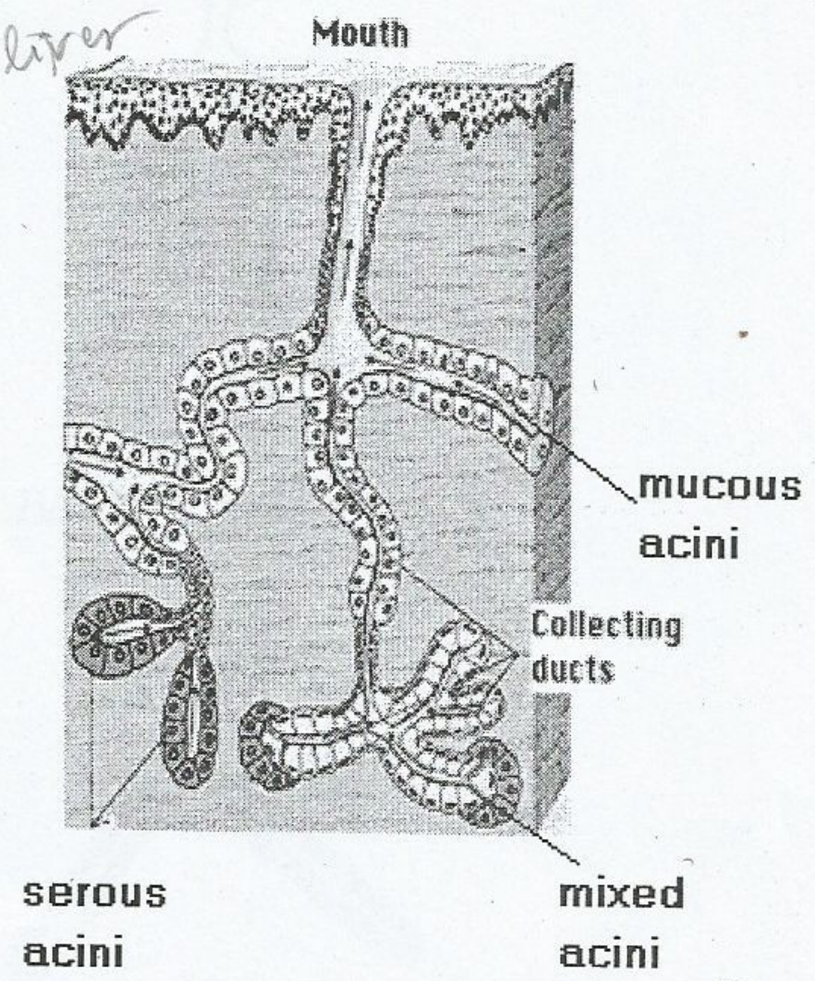
a. Exocrine glands: e.g. salivary glands.
b. endocrine glands: e.g. thyroid & suprarenal glands.
c. Mixed glands: (exocrine + endocrine function), e.g. pancreas. & liver

2- According to the number of cells

a. Unicellular glands: e.g. goblet cells.
b. Multicellular glands: e.g. salivary glands.

3- According to the nature of secretion

A) Serous glands: e.g. parotid gland.:
the acini is formed of by Cell has a spherical nucleus near the base, in apical cytoplasm
secretary granules are present, near the base the cytoplasm is basophilic and the lumen of the acinus is definite and smaller than that of the mucous acinus.

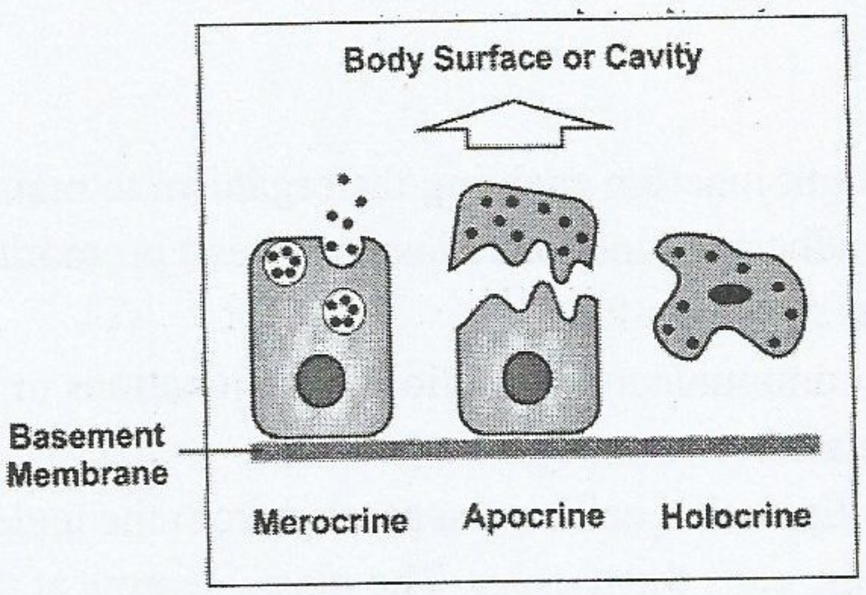


B) Mucous Glands:
The cells with clear the cytoplasm in the H/E preparation. The nucleus is small, dark and flattened against the basal membrane. The lumen is. bigger than in serous acinus and irregular. By electron microscope the main features are the "mucigen" droplets scattered between the Cytoplasmic organelles.
C) Mixed Acinus Glands: A mixed gland is one in which both mucous and serous acini are present or and one in which component acini have both mucous and serous cells. A mixed acinus is basically a mucous acinus with a small group of serous cells at its termination, the serous cells arranged in a crescent or half—moon fashion.

d Watery secreting glands e g sweat glands
e Waxy secreting glands e g glands of external ear
f. Fatty secreting glands: e.g. sebaceous glands.
g. Cellular secreting glands: e.g. testis & ovary.

4- According to the mode of secretion (changes that occur during secretion)

a. Merocrine glands: no changes occur in the secretory cells, during secretion, e.g.salivary glands
b. Apocrine glands: the apex of the cell is destroyed, during secretion, e.g. mammarygland.
c Holocrine glands some cells are destroyed, to form the secretion, e g sebaceousglands.



5- According to the shape of the secretory units (acini) and branch of ducts, exocrine glands are classified into:

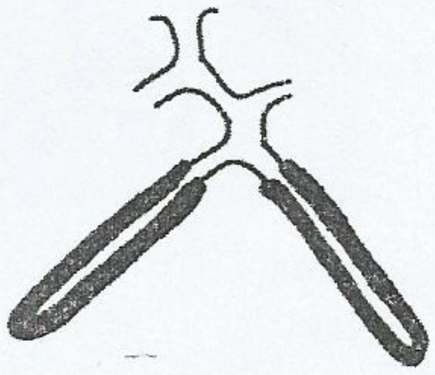
SIMPLE TUBULAR

intestinal crypts (glands)

SIMPLE BRANCHED TUBULAR

glands of fundus of stomach

COMPOUND TUBULAR



testis, liver & kidney

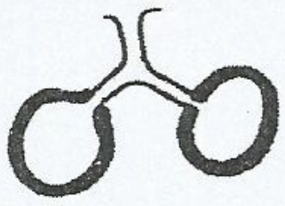
SIMPLE COILED TUBULAR

sweat glands

SIMPLE ALVEOLAR

sebaceous glands

SIMPLE BRANCHED ALVEOLAR



sebaceous glands

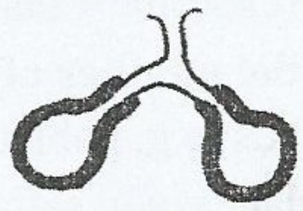
COMPOUND ALVEOLAR

mammary gland

SIMPLE TUBULOALVEOLAR

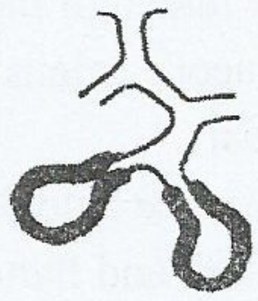
not found in man

SIMPLE BRANCHED TUBULO-ALVEOLAR



glands of the oral cavity

COMPOUND TUBULO-ALVEOLAR

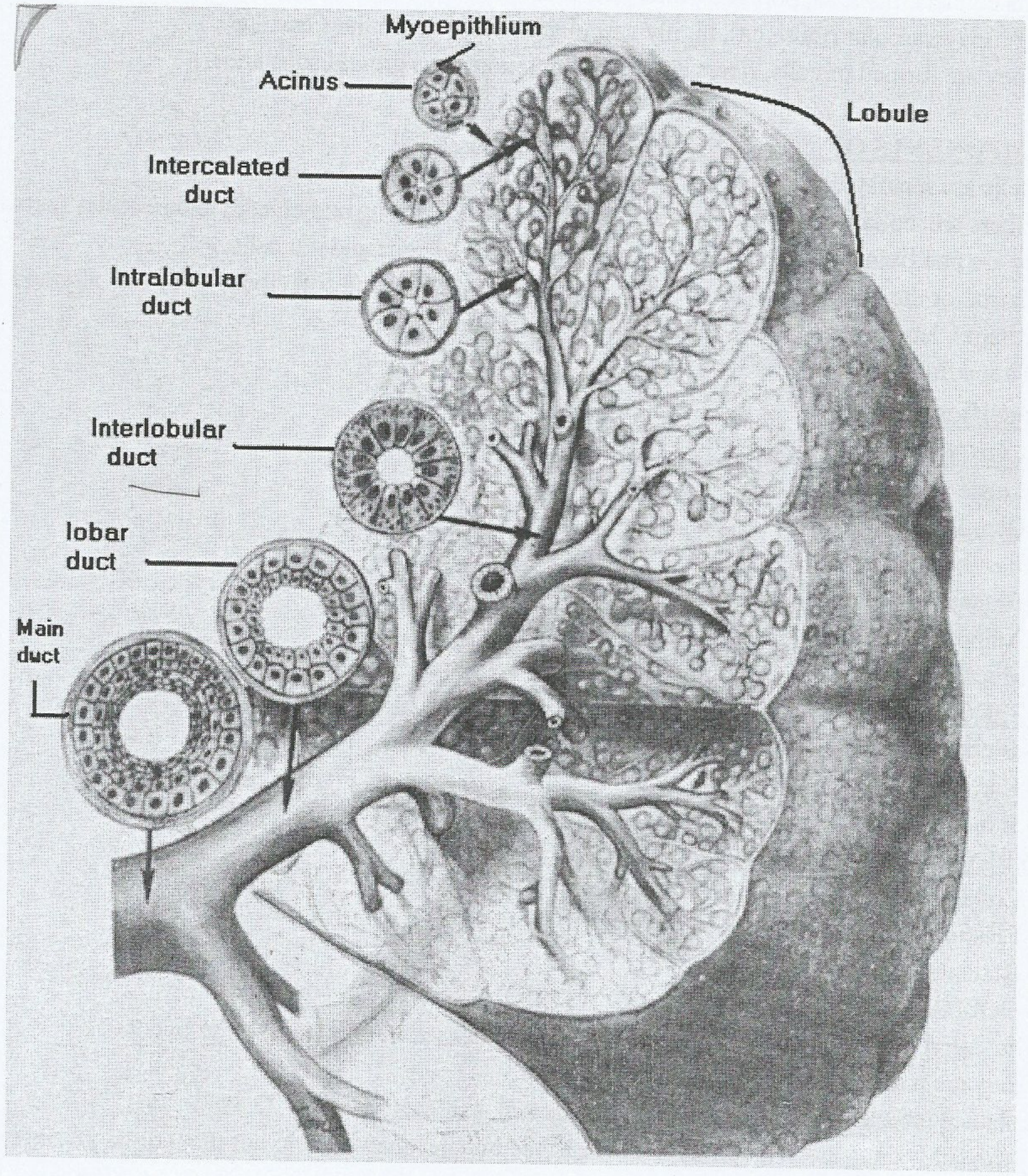


salivary glands and pancreas

gland as compact organ has two portions:

1- Parenchyma: secretory (functional part) part and ducts system.

2- Stroma: as connective tissue : capsule, trabeculae, reticular net-work.



CONNECTIVE TISSUE

Connective tissue is the group of tissues that develop from the mesodremic layer of the embryo. unlike epithelium, this tissue contains a wide intercellular substance in which the cells are widely separated from each other .

GENERAL CHARACTERISTICS OF CONNECTIVE TISSUE:

1- All types of c.ts are mesodermal in origin.
2- c.ts connect, hold, support and protect her body tissues.
3- c.ts may vascular (loose c.t), highly vascular(bone) or avascular (cartilage)
4- They are formed of cells, fibers and matrix or amorphous ground substance.

COMPONENTS OF THE CONNECTIVE TISSUE ARE:

1- Cells are separated from one another, have different types and functions.
2- Fibers are collagenous (strong and not elastic) elastic (strong and elastic) and reticular (network). They are non living material. These fibers are products of cells and not cells.
3-Matrix or the amorphous ground substance is either watery and soft (loose C.T), rubbery and firm (cartilage), hard and calcified (bone) or even liquid (blood)
4- Tissue fluid.

Classification

1– CONNECTIVE TISSUE PROPER

A- Loose or Areolar C.T
B- Dense C. tissue
C-Elastic C. tissue
D- Reticular tissue
E- Adipose tissue
F- Mucoid tissue

2- SPECIALIZED TYPES OF CONNECTIVE TISSUE:

A- Blood.
B- Cartilage
C- Bone

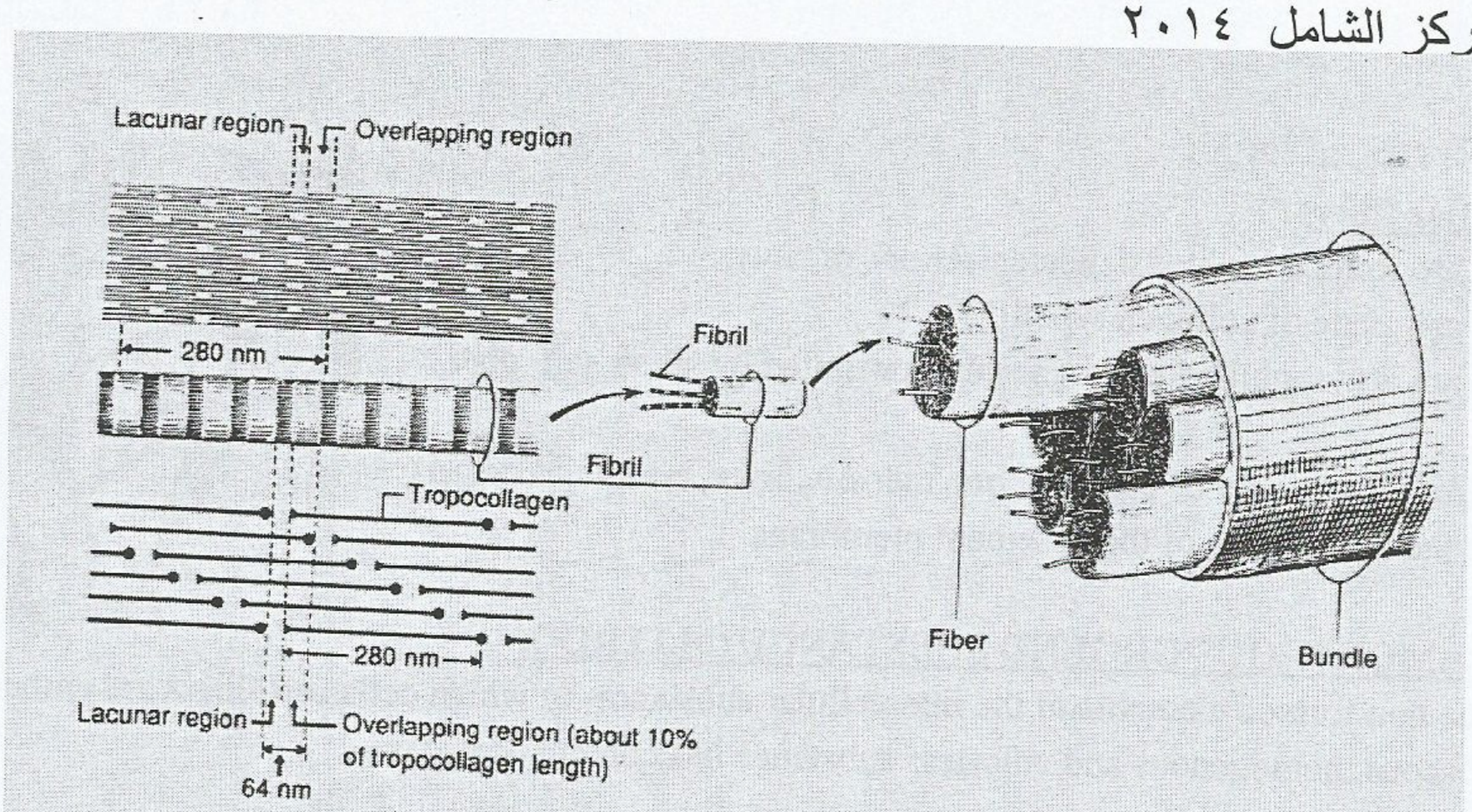
TYPES OF THE CONNECTIVE TISSUE FIBERS:

1- Collagen Fibers
2- Elastic Fibers
3- Reticular Fibers

1- COLLAGEN FIBERS

-The are colorless when present singly, but on condensation they are a white in color.
- They are made of collagen protein.
-They are effected by boiling, enzymes, acids and alkalizes
- With L/M, They are acidophilic with H&E. the bundles may branch, but the individual fibers do not.

With E/M the, each collagen fiber is composed of parallel fibrils. Each fibrils formed of microfibrils which consist of protein molecules" tropocollagen" arranged in a staggered fashion so to give the fibrils a cross banding form.



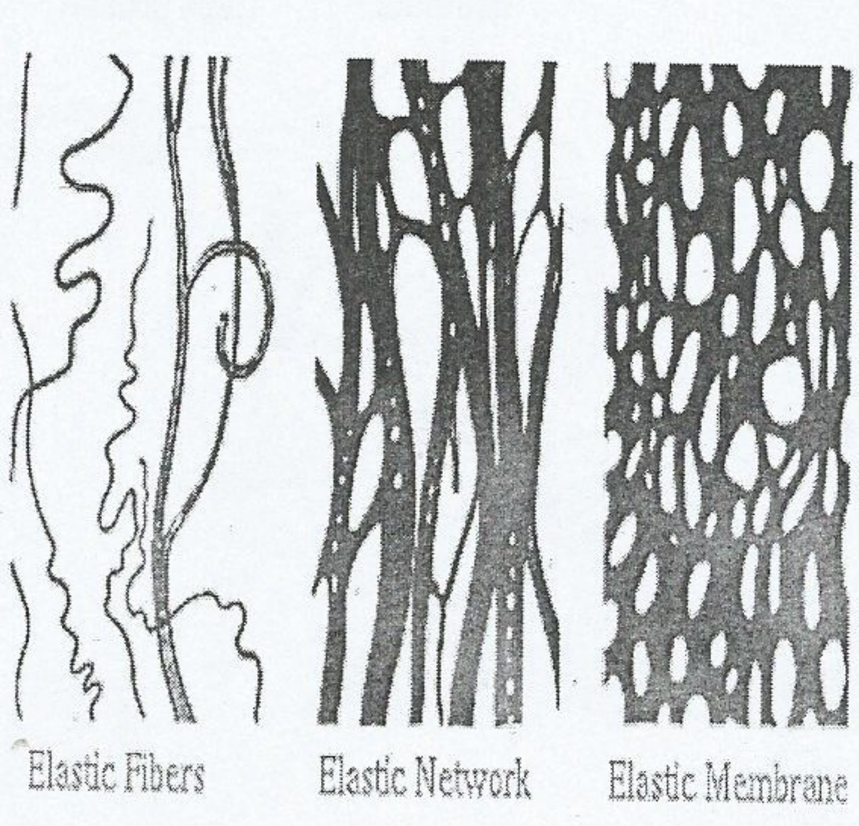
Schematic drawing of collagen molecules (tropocollagen), fibrils, fibers, and bundles. Under the electron microscope, the fibrils show a 64 nm periodicity of dark and light bands. This periodicity is explained by the stepwise overlapping arrangement of rodlike tropocollagen subunits, each measuring 280 nm. This arrangement results in the production of alternating lacunar and overlapping regions that cause the cross-striations characteristic of collagen fibrils

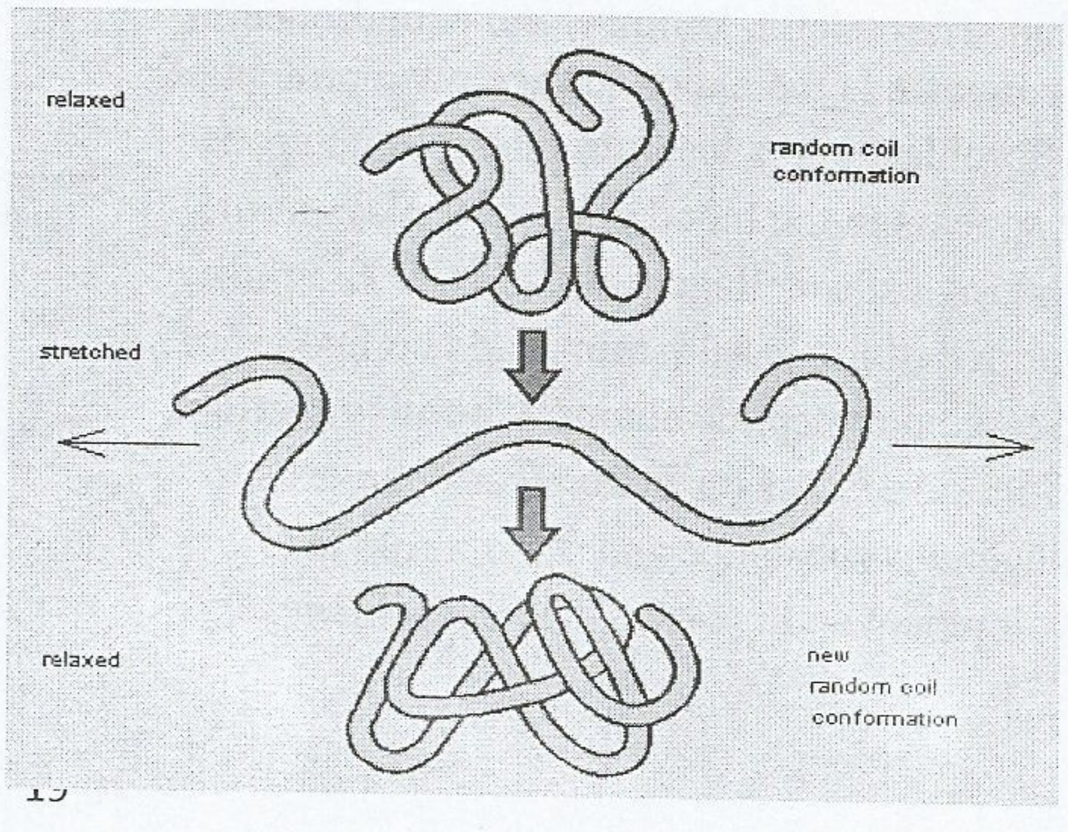
Formation:

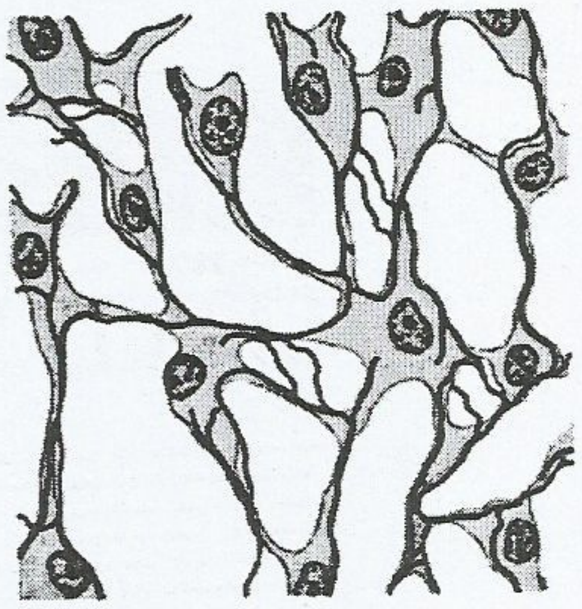
Collagen synthesis is done in the length endoplasmic reticulum in the form of protocollagen which is packed into vesicles and extruded from the cell surface. The protocollagen is than polymerized to molecules of the tropocollagen that become arranged side by side by side to form the collagen fibrils. Collagen synthesis is done mainly by some cells such as fibroblasts, osteoblasts, chondroblasts, and odontoblasts; also many other cell types produce this protein

Yellow elastic fibers

- They appear yellow on condensation
- They made of elastin protein (highly resistant to chemicals and boiling)
- They appear as thin branching fibers
- They are specially stained Orcein (dark brown)
- They provide the tissue with the power of stretch and elasticity.







Reticular fibers

-They are formed of the a delicate network of fibers

-They are made of collagen type III.

-They are argyrophilic i.e. they are demonstrated by silver salt give black.

-The form the stroma of organs (bone marrow, liver, lymphoid organ) and in the basal lamia of the basement membrane.

THE AMORPHOUS GROUND SUBSTANCE (MATRIX):

It is the non formed elements of the intercellular substance, in which cells and fibers are embedded

It is viscous, homogenous and colorless substance has content of water.

Function:

1- Lubricant material.

2- Barrier to foreign particles.

3- Provides the medium for passages of O2 and nutrition substances from capillaries to the cell and the waste products of their metabolism in the reverse direction.

Types:

1-Glycosaminoglycans(GAGs)::

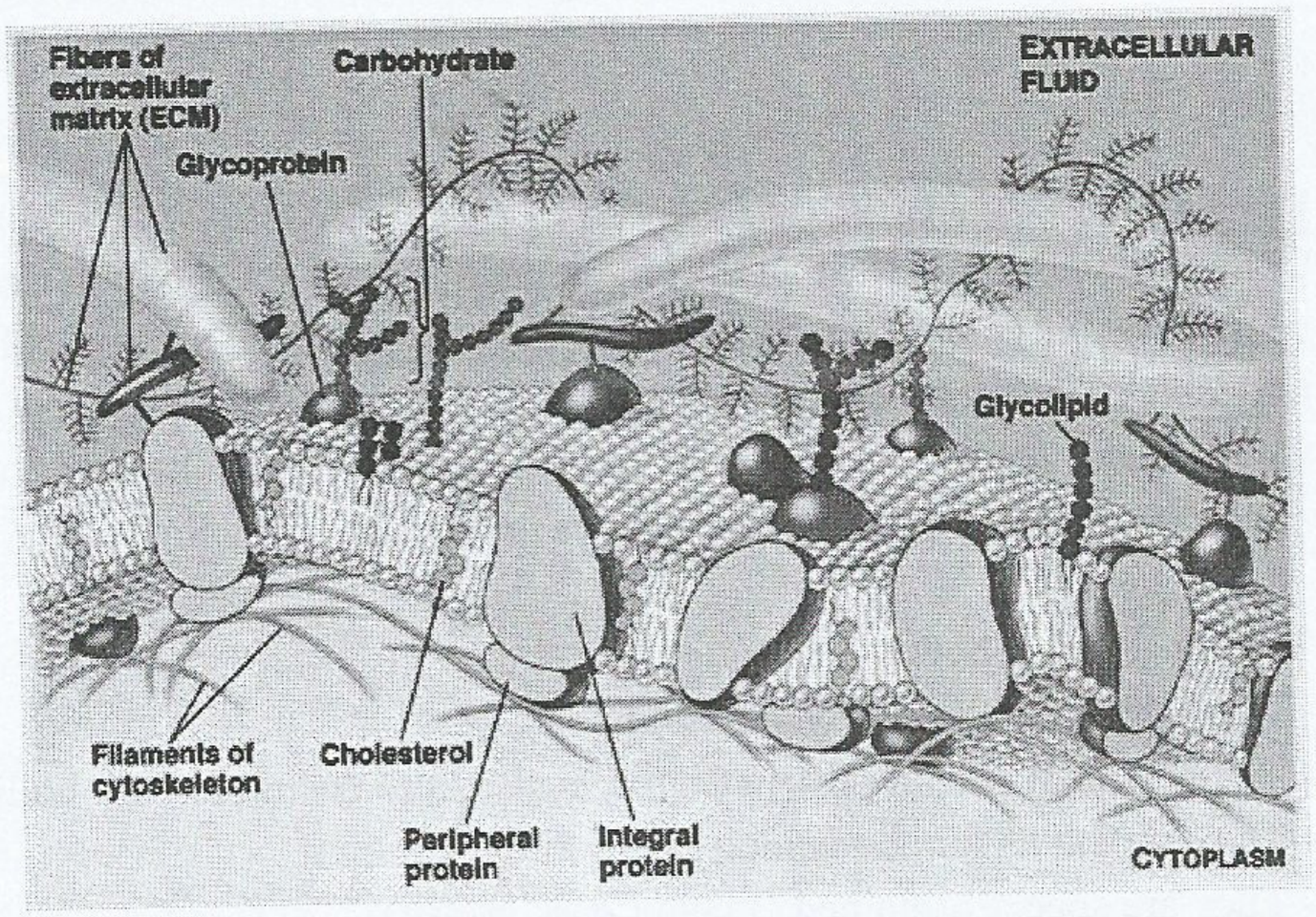
A- Non-sulphated type (Hyaluronic Acid)

B- Sulphated type (Chondroitin Sulphated):

Is the most common type of glycosaminoglycans and predominates in cartilage ,bone; and blood vessels.

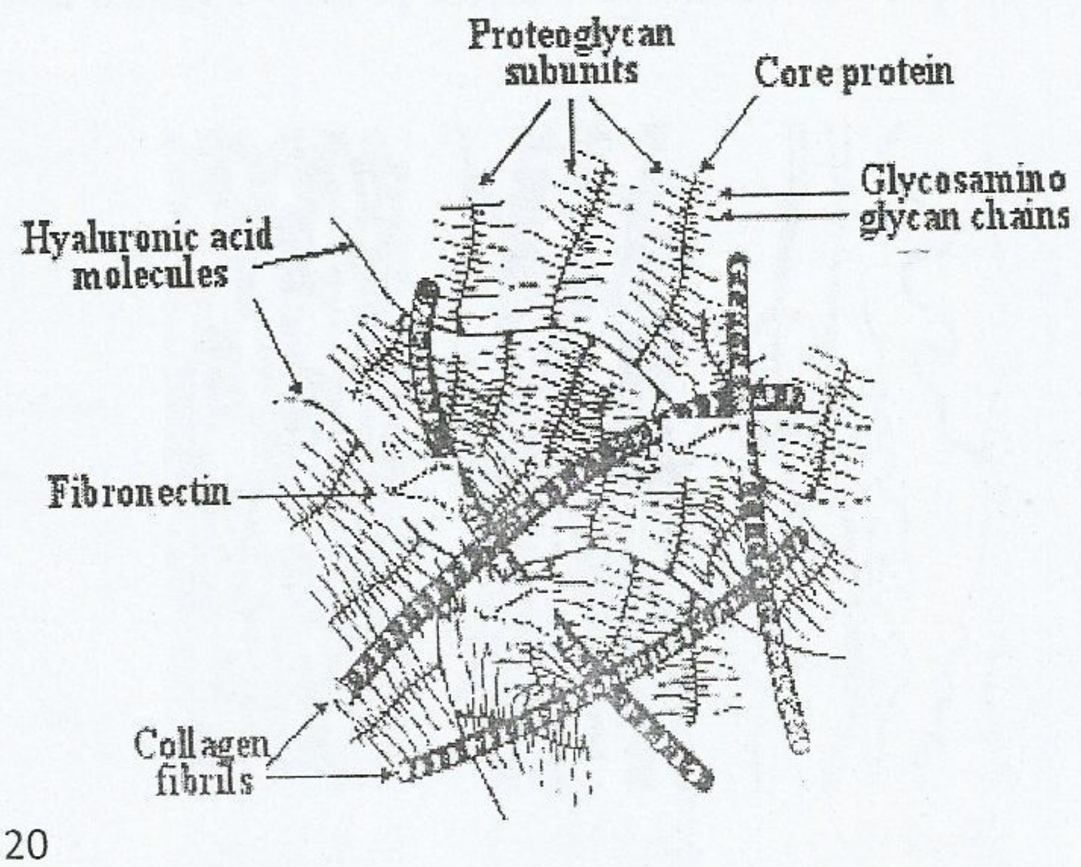
2- Proteoglycans:

Consist of a core protein from which many GAGs extend. These large molecules are shaped like a bottle brush.



3- Glycoprotein

Include fibronectin, laminin, and chondronectin. **Fibronectin** is the major surface glycoprotein of the fibroblast but is lost into intercellular space and appears in the blood plasma. It plays a role in linking cells, collagen, and GAGs. **Laminin** is formed of the basal laminae and composed of two large polypeptide chains. **Chondronectin** is an adhesion factor for mature cartilage cells to collagenous substance and plays a role in development and maintenance of cartilage.



CELLS OF THE CONNECTIVE TISSUE

A-The Fixed Cells:

They are a relatively stable population of long-lived cells.

They include fibroblast, fixed macrophages, adipose cells, mesenchymal cells, Pericytes, endothelial cells and reticular cells.

B-The Free Cells:

They are changing population of motile cells that enter the C.T from blood and wander through its ground substance. Most of these are short- lived. They include free macrophages, plasma cells, mast cells, pigments cells, and

1- undifferentiated mesenchymal cells:

Found in the embryonic C.T. Branched cells with large , pale , oval nucleus.

Functions: they differentiated to give the other types of connective cells . In bone marrow , they give origin to blood elements

2-Fibroblasts

-Found in all types of C.T proper

-Flat branched (spindle-shaped)

-Large pale oval nucleus .

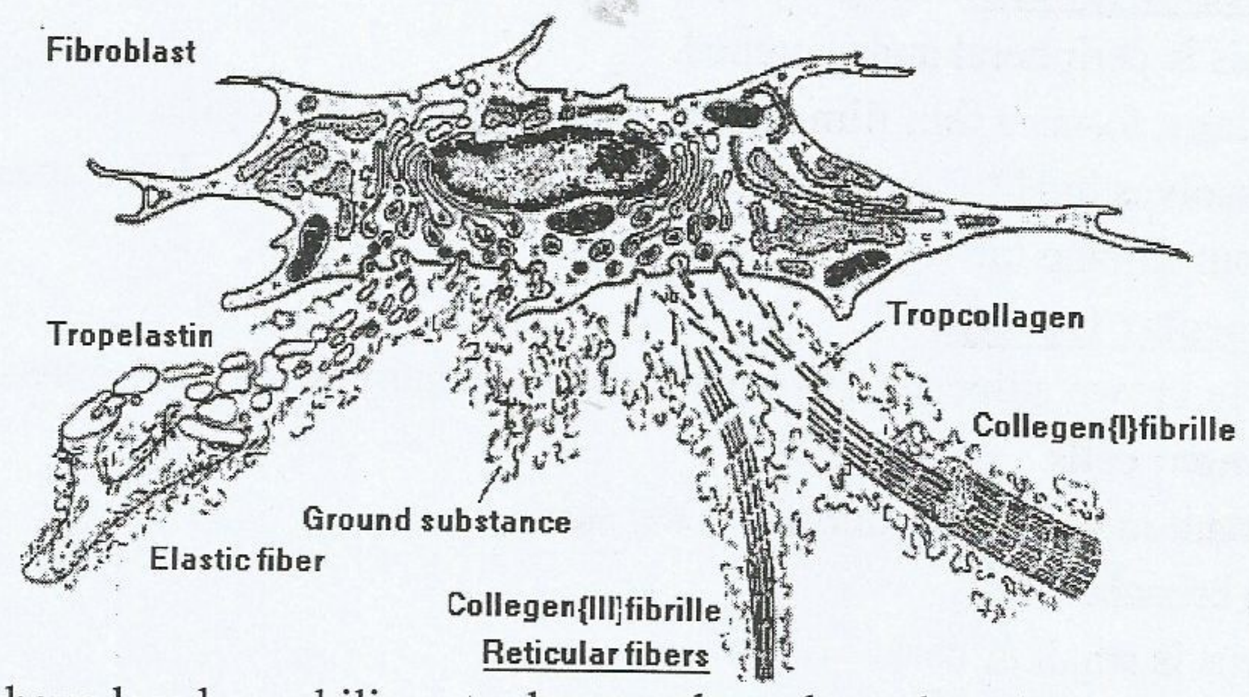
-Cytoplasm is basophilic.

-Function:

1-secretion of collagen, elastic and reticular fibers

2- secretion of the ground substance.

3- Healing of the C.T., after injury.



old inactive fibroblasts = fibrocytes, have less basophilic cytoplasm and condensed nucleus

3- macrophage(fixed and non-fixed)

-The are derived from blood monocytes after their migration to C.T

-They are branched cells with multiple processes

-Their cytoplasm is rich in lysosomes and RER

-They have oval eccentric nuclei.

Function:

1- highly phagocytic activity cells

2- Fusion of more than macrophages, forming large multinucleated cells called "foreign body giant cell

3- play role in immunity .

4- secreted interferon as antiviral agent.

4- mast cells

-They are present in groups along blood vessels.

-Are small cells, may be oval or irregular in shape.

-The cytoplasm is filled with large basophilic granules which stain metachromatically with methylene blue.

Nucleus is eccentric.

Functions:

1- Heparin secretion: Heparin acts as an anticoagulant, preventing blood clothing (thrombosis) inside the vessels .

2-Histamin synthesis and storage (mast cells synthesis histamine and store it as membrane- bound granules until it is released).

4- Serotonin production which occurs only in some species not inthe man

5- plasma cells

-Abundant in lymphoid tissues.-Develop from B-lymphocytes.

-Oval in shape.

-nucleus is eccentric with a cart-wheel (clock-face) appearance.

-Cytoplasm is basophilic.

Function: secretion antibodies (humeral immunity)

6- Fat cell(adipocytes)

-They found mainly in adipose tissue, and along blood vessels.

- Unilocular fat cells:-Large spherical cells

-Nucleus is peripheral and flattened.

-Cytoplasm forms a thin film around a single large fat droplet.

-Fat dissolves in H&E so the cell appears as large vacuoles. Fat stained with Sudan black.

Function: storage fat

Multilocular fat cells:

Found in brown adipose C.T- small cells with many small fat droplets.

7- Pigment cells

-Abundant in C.T of the dermis of the skin.

-Small branched cells.

-Nucleus is small & dark.

-Cytoplasm is rich in melanin pigment .

-They are macrophages that have engulfed melanin granules, formed by melanocytes(melanin-forming cells).

Function: Storage of melanin , which protects against ultraviolet rays of the sun.

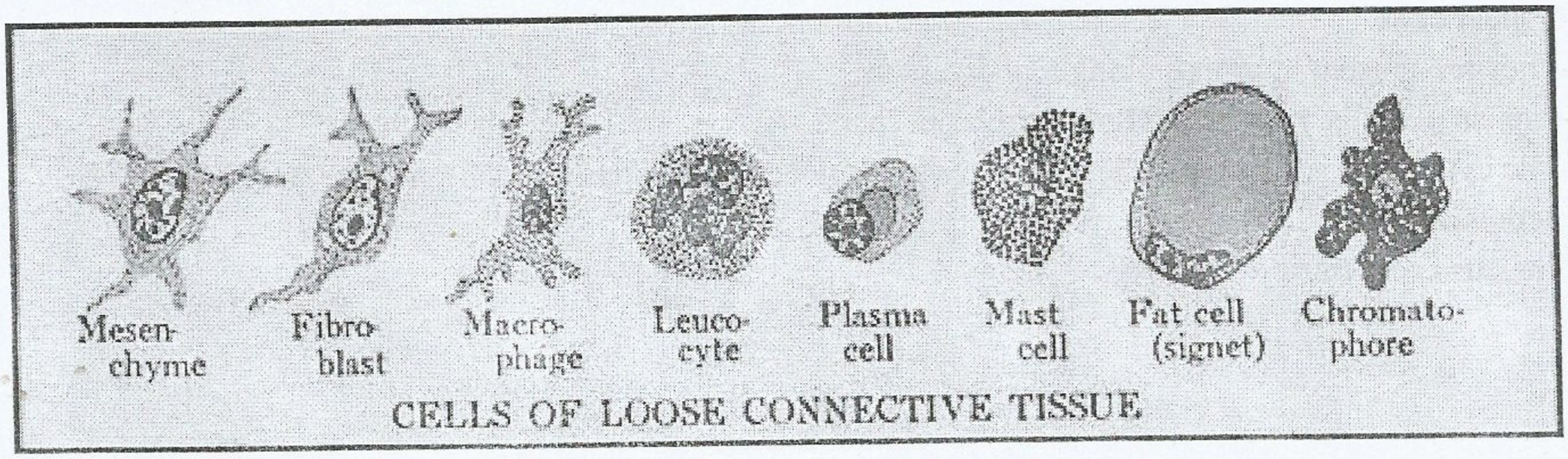
8- leukocytes.

migrate from blood stream to connective tissue

1- lymphocytes: they migrate to the area of chronic inflammation

2-Neutrophils they migrate to the area of acute inflammation

3- Eosinophils they migrate to the site of allergy & parasites.

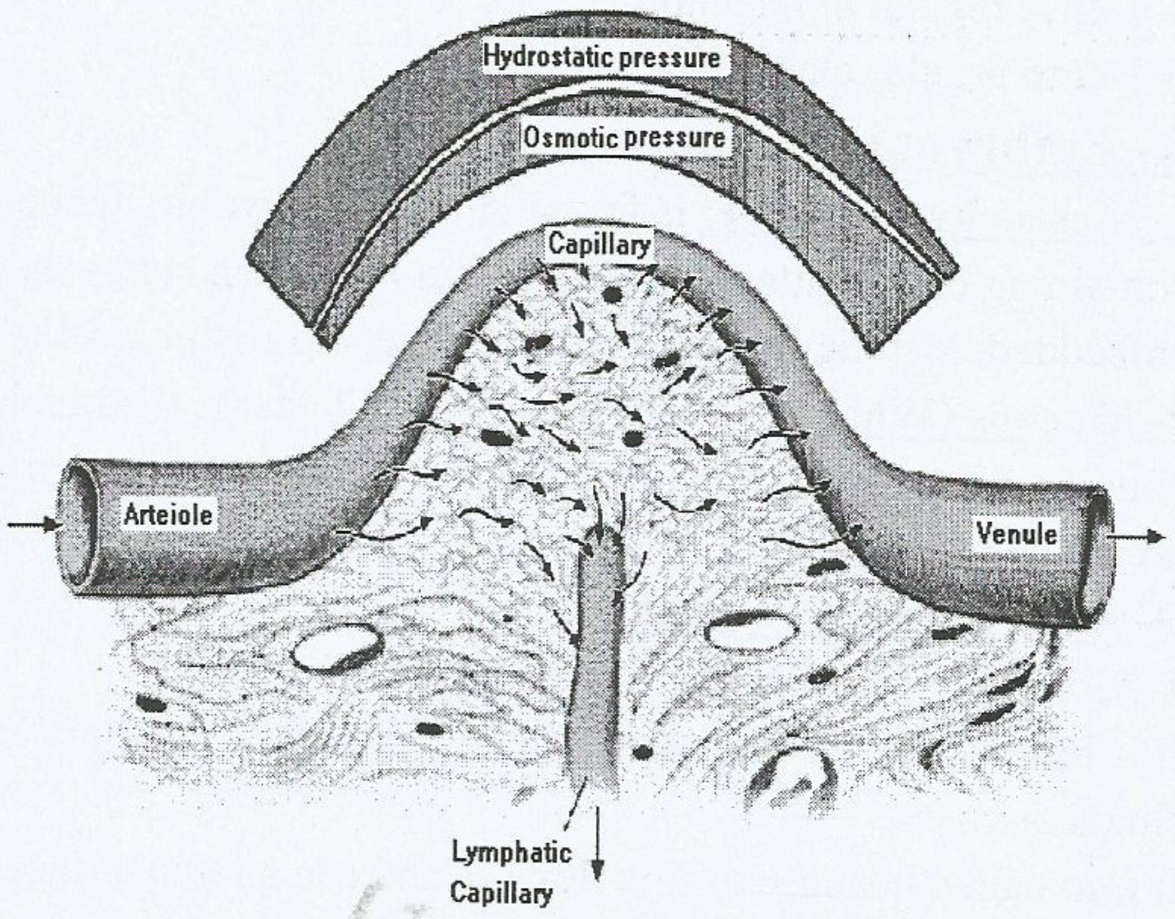


CELLS OF LOOSE CONNECTIVE TISSUE

TISSUE FLIUD

TISSUE FLUID

The blood vascular system brings oxygen and food materials to the cells and removes waste products from the cells. It must be remembered that the majority of cells are not close to capillaries, are at some distance from any blood vessels. Thus , it is necessary a (linking) between blood and cells, this is through the tissue fluid ,present in the intercellular spaces and related to the intercellular substance .In the places where the amorphous ground is present in the form of a "sol" , the tissue fluid acts as the dispersion medium ; and where the intercellular substances are present in the form of "gel" , the diffusion occurs through the bound water which was obtained from the tissue fluid at the time of formation of the intercellular substance.



Composition:

The tissue fluid is similar to blood plasma in its contents; those can diffuse and through capillary walls. Blood contains cellular elements and plasma which contains both crystalloid and colloids. Only water and crystalloids diffuse really through the capillaries walls. The blood cells and the majority of colloids remaining in side blood vessels.

Formation:

The formation of the tissue fluid is due to **hydrostatic pressure of the blood**, a consequence of the heart pumping, which forces water and crystalloids to pass through very thin capillaries wall.

Absorption:

The absorption of tissue fluid is very important; otherwise the tissues would become swollen with excess fluid, increase considerably, causing "edema". There are two mechanisms for absorption and together they balance the rate of formation of the tissue fluid.

1- Protein Osmotic Pressure (op):

Of the blood colloids encourage the retention water back into capillaries

2-Hydrostatic pressure:

At venous end the tissue fluid is drawn into the vessel due to the osmotic pressure becomes greater than hydrostatic pressure.

CLASSIFICATION OF THE CONNECTIVE TISSUE PROPER

According to density of the matrix and to the main cells and fibers, the connective tissue proper is classified into:

A-Embryonic C.T

1- Mesenchymal C.T.

2- Mucous C.T.

B- Adult C.T.

1- Loose C.T.

a- Areolar tissue.

b- Reticular tissue.

c- Adipose tissue (white and brown)

2- Dense C.T.

a- Dense irregular.
b- Dense regular collagenous
c- Dense regular elastic.

A- Embryonic Tissue.

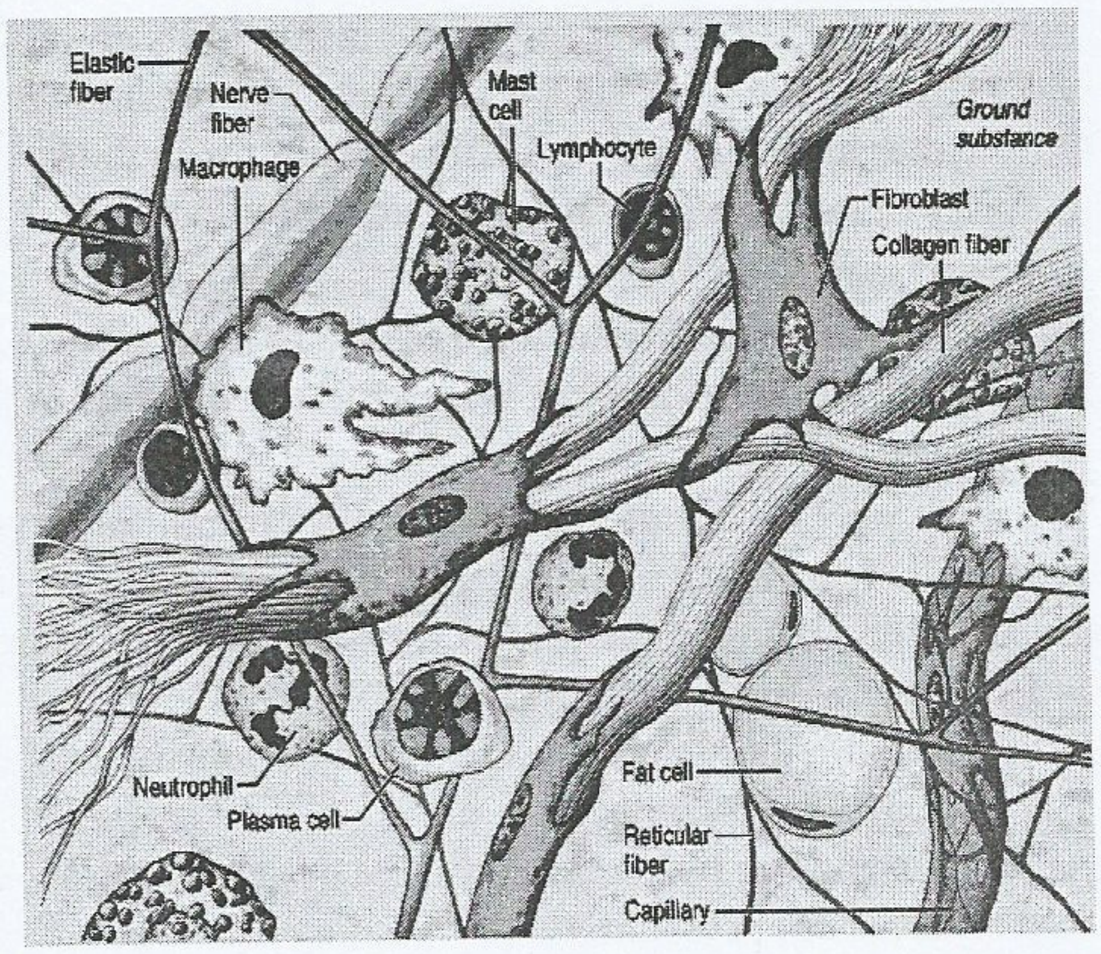
1- Mesenchymal tissue: is found only in embryonic. It consists of a gel-like amorphous matrix containing only scattered reticular fibers in which stare- shaped, pale-staining mesenchymal cells are embedded. Mitotic figures are often observed in these cells.

2- Mucous (Wharton's jelly): is loose C.T that is the mucin constituent of the umbilical cord. It consists of a jelly- like matrix with some collagen fibers in which large satellite- shaped fibroblasts are embedded.

B- Adult Connective Tissue

1-AREOLAR (LOOSE) CONNECTIVE TISSUE

It is loose type , that contains potential cavities (Areolar) which accommodate large amounts of fluids or gases.
It also called because of it is flexible and can stretch without damaged.
It contains all types of cells and fibers.
Site: In every microscopically places in the body except the C.N.S. Connecting all organs and tissue together e.g. Dermis of the skin.
Submucosa of G.I.T and serous membrane.

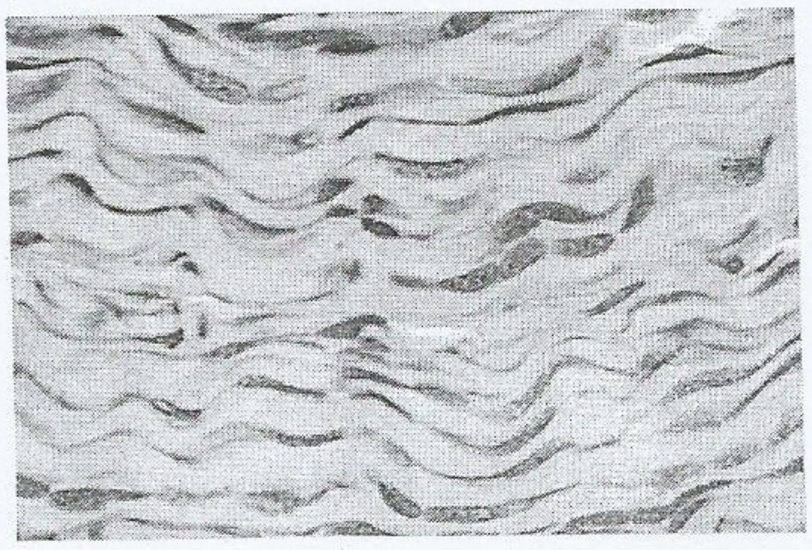


2- ADIPOSE CONNECTIVE CONECTIVE TISSUE

Group of fat cells (adipocytes) forming lobes and lobules which separated from each other by septa. The septa carry the blood vessels, lymphatic, nerves with loose C.T between cells.
There are two types :
White adipose : with largest fat cells ,contains single fat droplet. Poor blood supply
Present in subcutaneous tissue , around the kidney.
Function: storage the fat as energy , insulation of heat,
Brown adipose: fat is brown in color due to rich blood capillaries, and present of cytochrom pigment in the cytoplasm ofsmaller fat cells.
Function: on exposure to cold it releases heat to warm the body.

3-Dense white collagen C.T.:

When collagen fibers are predominate a dense C.T. it is called "dense white collagen" because in fresh state it is white in color. According to the arrangement of the fibers, two types are found; irregular and regular dense white collagen C.T.



a- Irregular dense white C.T.:
The collagen fibers are arranged in irregular pattern. There is little ground substance and the cells are mainly fibroblasts and

fibrocytes.

Function and Sites: Irregular dense white collagenous C.T. can withstand stretch from several different directions in multiple directions e.g. in deep fascia, dermis of the skin, fibrous capsule of organs (liver, lymph nodes, etc), fibrous sheath of cartilage (perichondrium)and bone(periosteum).

4-ELASTIC (YELLOW) CONNECTIVE TISSUE

When elastic fibers are predominant in a dense C.T. it is called yellow elastic C.T. it is yellow in color in fresh state. It is formed of regular parallel elastic fibers bound together by small amount of the delicate fibers with many fibroblasts and fibrocytes.

6-RETICULAR CONNECTIVE TISSUE

It is present in the Stroma of organs, glands and bone marrow.

It is formed of a network of reticular fibers and reticular cells. The reticular cells are satellite shape with large pale nucleus and many processes, the cells are continues with each other by their processes. These cells resemble the U.M.C; they can differentiate to macrophages, fibroblast and others cells.

Function: It provides support for organ architecture

SKELETAL CONNCTIVE TISSUE
CARTILAGE & BONE

General Characteristics of cartilage:

1- Cartilage is a specialized form of connective tissue in which the firm consistency of the extracellular matrix allows the tissue to be bear mechanical stresses.

2- Cartilage (matrix) is avascular and is nourished by the diffusion of the nutrient from capillaries in adjacent C.T. (perichondrium) or by synovial fluid (where the perichondrium is absent).

3- Cartilage has no lymphatic vessels or nerves.

4- Cartilage is covered from outside by C.T. sheath called perichondrium.

5- Cartilage is formed of cells (chondrocytes) are relatively few and are located in cavities called lacunae embedded in rigid matrix (because it contains Chondroitin sulfuric acid, but with some degree of flexibility), and varying proportion of fibers.

There are three types of cartilages

1- Hyaline cartilage.

2- Yellow elastic cartilage.

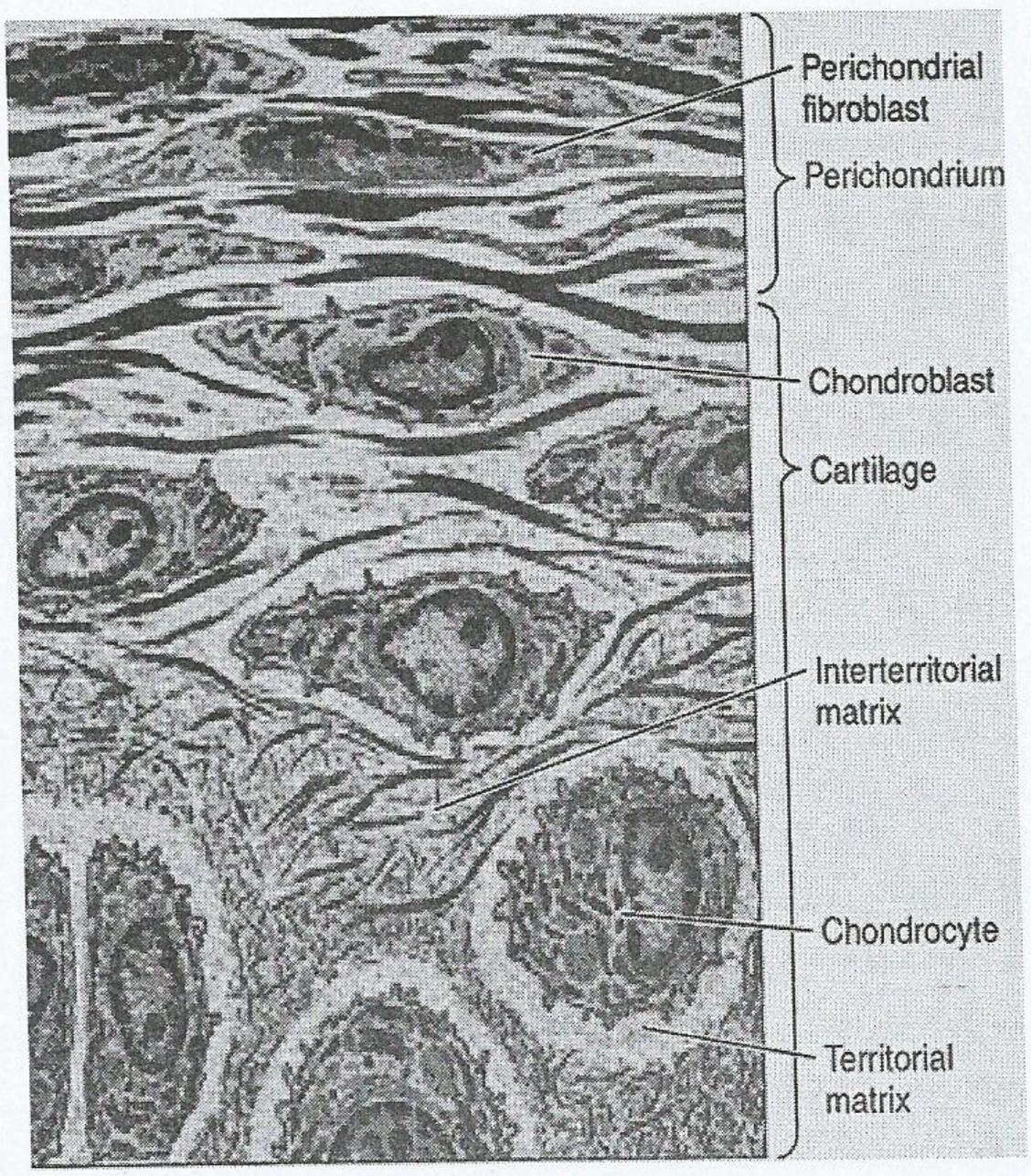
3- White fibro-cartilage.

Perichondrium:

Hyaline and Elastic Cartilages are covered with dense C.T. layer (except in articular cartilage of joint) called perichondrium.

As it is vascular C.T. formed of two layers:

- a- an outer fibro-elastic layer and
- b- an inner chondrogenic layer formed of chondroblasts



Function:

1- provide cartilage nutrition, appositional growth, and regeneration

2- It contains blood and lymph vessels and nerves.

Cells of the Cartilage:

1-Chodroblasts or Chondrogenic Cells

Structure : Chondroblasts are oval or spindle in shape with basophilic cytoplasm. They are present singly Parallel to the inner aspect of perichondrium where started to secrete matrix around themselves.

Function:

They develop from mesenchymal cells. They are cartilage forming cells.

1- They synthesis and secrete the components of the cartilage matrix and its fibers (collagen fibers).

2- Because they can divide, they are responsible for the oppositional growth of cartilage.

When Chondroblasts are mature and imprisoned inside lacunae are called Chondrocytes.

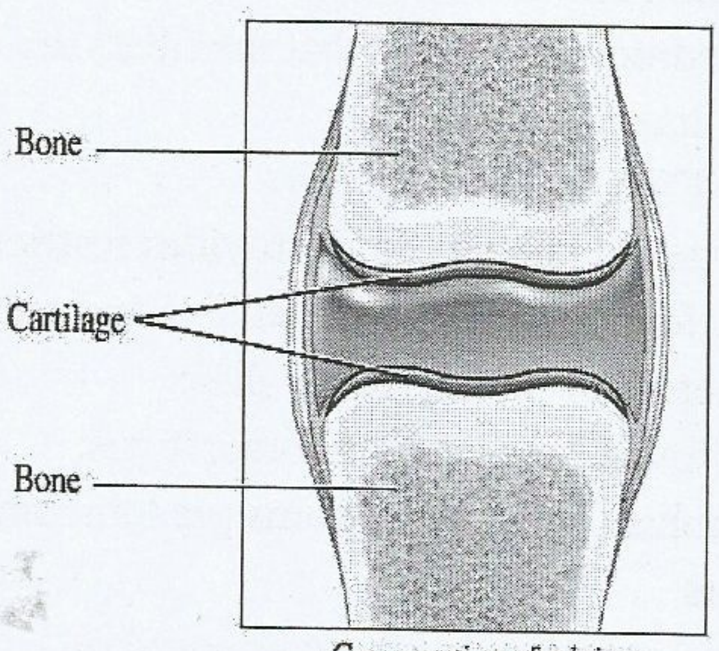
2- Chondrocytes

LM:

spherical in shape when single and triangular or semicircular when in groups (cell nests).
They are embedded in matrix inside spaces called lacunae. The lacunae are surrounded by deeply basophilic condensed matrix called **capsule** .Mature Chondrocytes can divide.
Each cell has dark nucleus and basophilic vacuolated cytoplasm.
Function: Chondrocytes are responsible for the formation and secretion of the collagen fibers (mainly type II), proteoglycans, Hyaluronic acid and chondronectin

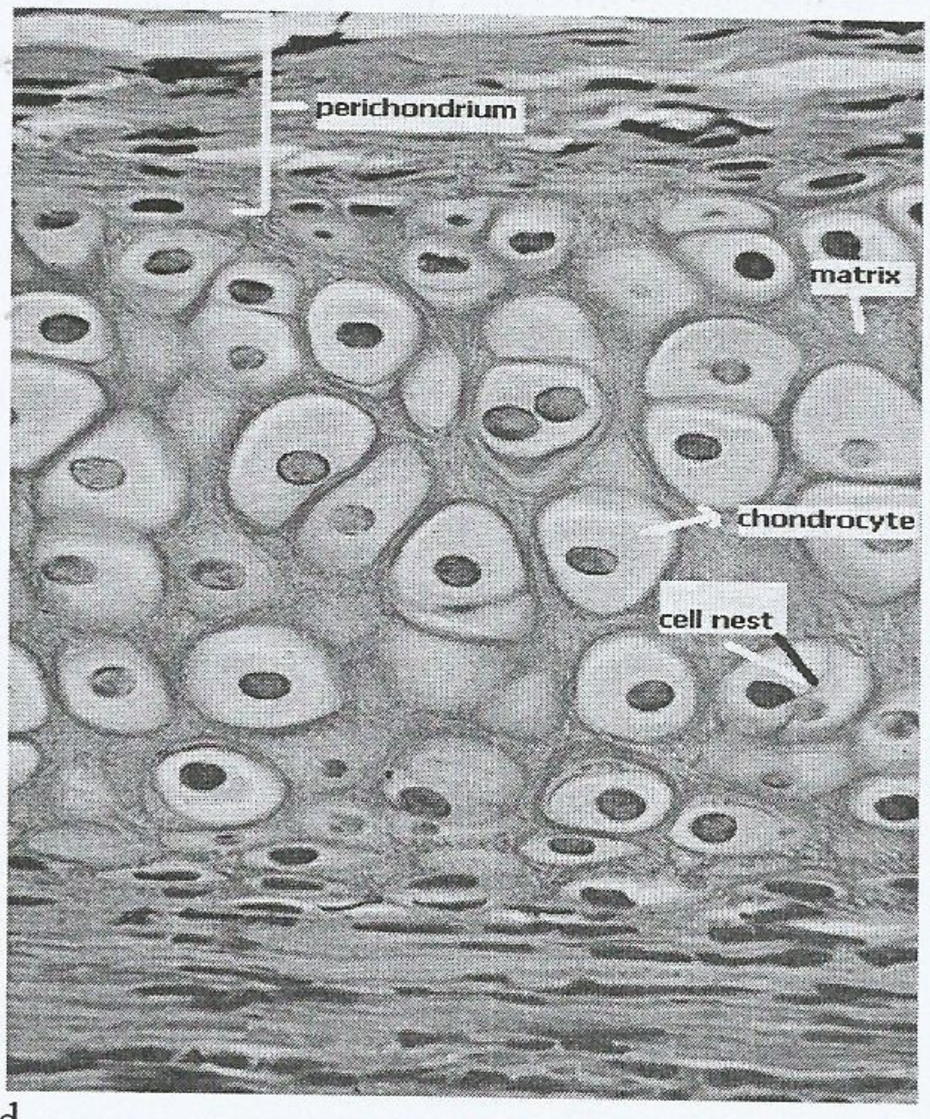
1- Hyaline cartilage

Characteristics:
It is the commonest type of cartilage, white blue in color and it has a glassy and translucent in fresh condition.
Site:
- In prenatal life, it forms most of skeleton of the fetus before it is replaced by bone.
- In postnatal life, it is present in the epiphyseal disc till they are replacing by bone.
- In adult, it persists mainly in the ventral ends of ribs, in the walls of upper respiratory passage (trachea, bronchi, nose and larynx) and in articular cartilages of joints.



Cross section of a joint

STRUCTURE OF THE HYALINE CARTILAGE:
Perichondrium:
Hyaline cartilage is covered by perichondrium (Peri=around), except on the articular ends in joints. It has two layers, an outer white collagen fibrous vascular layer and an inner cellular Chondroblasts.

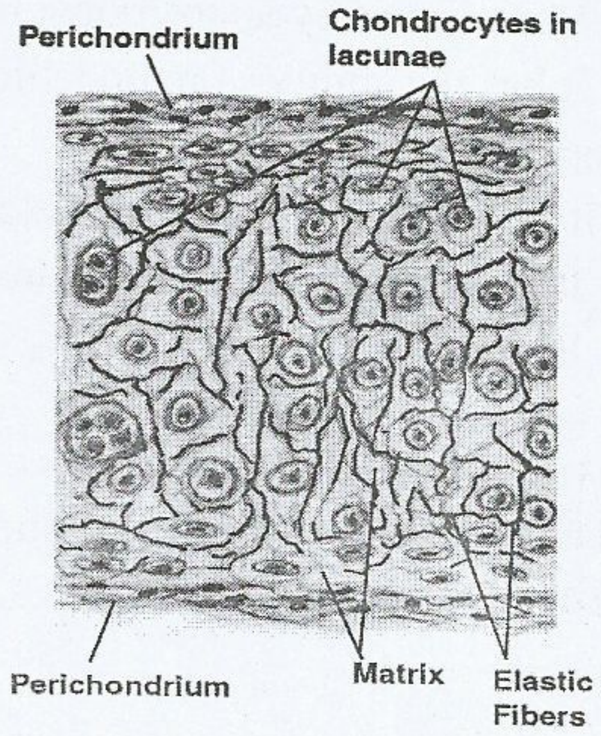


Matrix:
The matrix contains both collagen and elastic fibers. It appears clear basophilic (Gr. Hyalos=glass) because matrix has the same refractive index as collagen and elastic fibers, so fibers cannot be seen at the LM level. The matrix is condensed around the lacunae formed the (capsule) that contain Chondrocytes (cell nest).
Cells:

Mature Chondrocytes can divide, are located inside lacunae and they are embedded in the matrix forming cell nest.
Young Chondrocytes (Chondroblasts).

2-Elastic cartilage

This type of cartilage is similar in its structure of hyaline cartilage.
But:
a- The matrix is rich in elastic fibers which surrounded the cartilage cells. The elastic fibers are continuous with those of perichondrium.



b- This cartilage is flexible and is yellow on color duo to presence of elastic fibers.

Sites:

Is found in the external ear (ear pinna), auditory (Eustachian tube), epiglottis and some cartilages of larynx where elastic recoil is needed.

2 — White fibro cartilage:

The spheroidal chondrocytes are grouped in hyaline capsules which are separated from each other by a matrix rich in collagenous fibers. The collagenous fibers form bundles that separate the rows of Chondrocytes. Notice that the fibers are stained reddish with eosin while the matrix is stained bluish with haematoxylin.

FUNCTION AND SITES

It attached bone to bone provides restricted mobility under great mechanical stress .

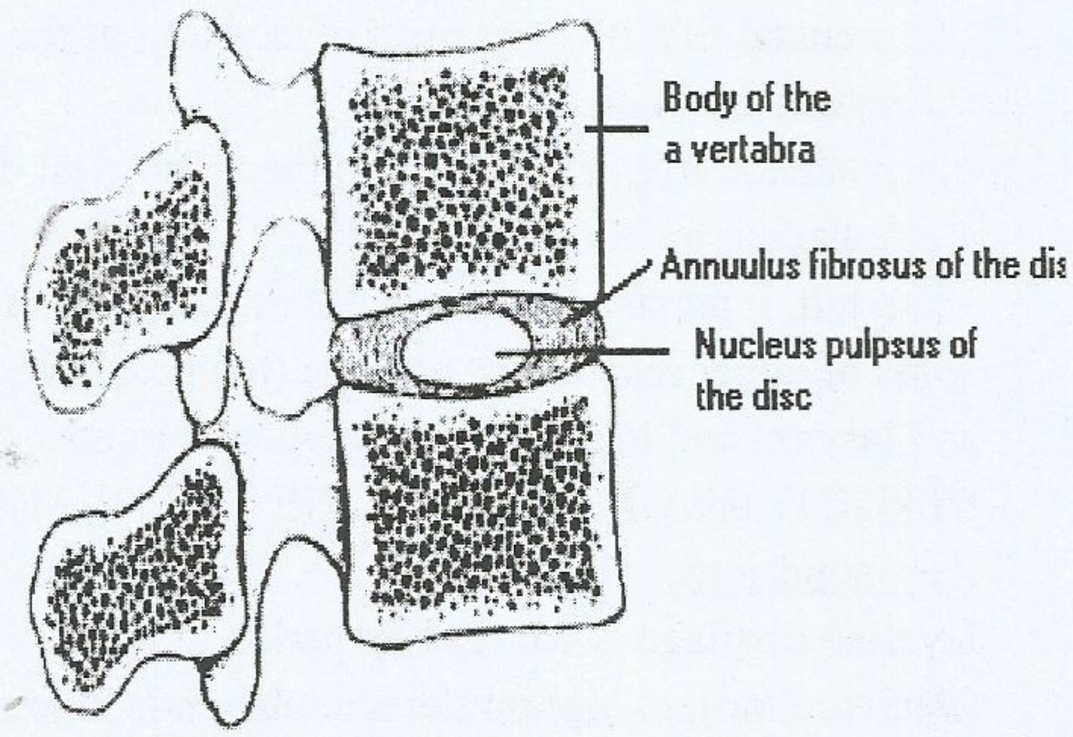
It is found in intervertabral disc and pubic symphysis.

Structure of intervertabral disc:

it is found between vertebrae. It has:

1-anulus fibrosus - contains predominantly circular fibers

2-nucleus pulposus - is composed of glycosaminoglycans and proteoglycans with cartilage cells.



Growth of cartilage:

1- Interstitial growth: the proliferation (division) of young chondrocytes within the substance of cartilage and subsequent to expand from within.

2-Appostional growth: the proliferation of chondroblasts derived from the perichondrium and subsequent formation of intercellular substance, will add layers of new cartilage from outside

BONE:

General Characteristics:

1- Bone is special types of dense connective tissue which is mesenchymal in origin.

2- Bone consists mainly of intercellular substance (matrix), which is calcified as it is formed. Bone cells are present in lacunae within the matrix.

3- The outer and inner surface of the bone are covered with connective tissue layers called perichondrium and endosteum respectively,

4- Bone cells receive their nutrition and oxygen blood vessels in the Canaliculi that are found within the avascular tissue.

5- Bone grows by appositional mechanism only

6- It has the ability of remodeling according to the stress.

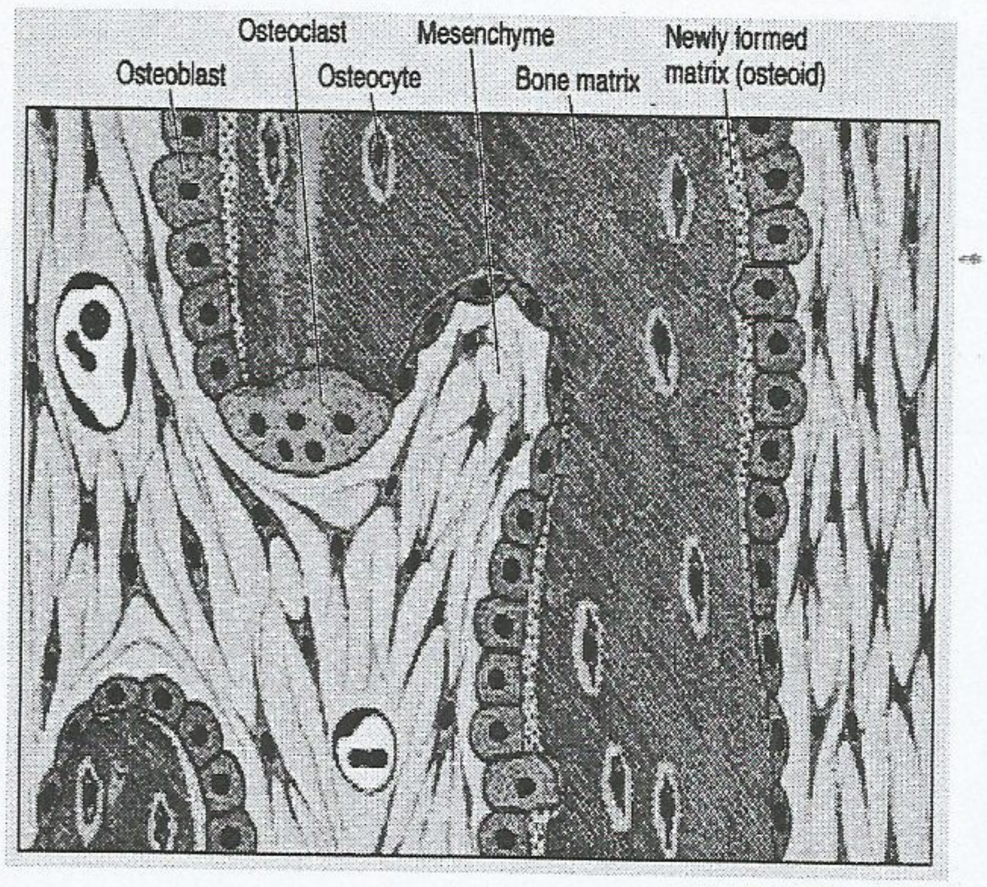
General Functions:

1-It forms the main part of skeleton.

2- It gives mechanical protection to the vital viscera as brain, heart and lungs.

3- It store for calcium which is important for:

- -The enzyme systems.
- -The muscular contraction.
- -The transmission of nerves impulses.
- -The blood coagulation.



-The cell adhesion.

4-It is site for bone marrow

Constituent elements:

cells, fibers, matrix.

A-Bone Cell: They are:

1-Osteogenic cells.

2-Osteoblasts.

3-Osteocytes.

4-Osteoclasts

1-Osteoprogenitor cells or steam cells of bone:

Origin: are embryonic mesenchymal cells or Pericytes around of the blood capillaries

Site: present in osteogenic layers of periosteum and endosteum

Structure:

LM: They are small flat, spindle-shape with pale basophilic cytoplasm and oval nuclei.

Function: those possess mitotic potential and ability to differentiate into osteoblasts when needed (during growth and repair).

The hormone calcitonin of the thyroid gland seems to direct the differentiation of osteogenic cells into osteoblasts

2- Osteoblasts (young bone cells):

Origin: They arise from activated osteogenic cells

Site: They are located at bone surfaces, side by side as in way resembling simple epithelium, and applied to bone spicules.

Structure: small irregular round cells with cytoplasmic processes.

The cytoplasm: is a deeply basophilic .

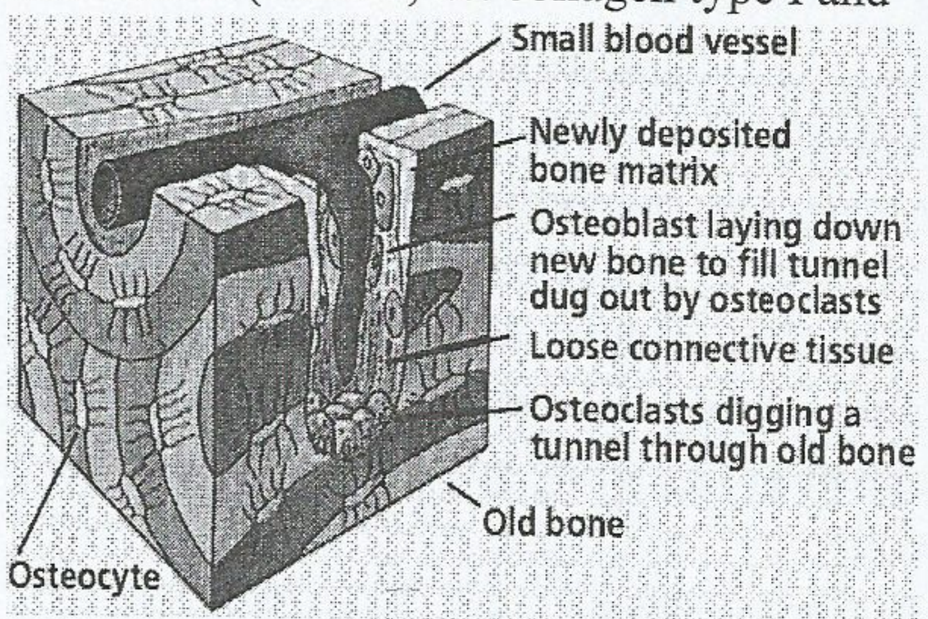
Nucleus: is single, large, oval and eccentric with prominent nucleolus.

Function: is bone builder through:

1-Synthesis and secretion of the organic component of bone matrix (osteoid, i.e. collagen type I and glycoprotein).

2-Osteoblasts secrete an alkaline phosphate which stimulates deposition of calcium salts in matrix

When the osteoblasts are trapped inside lacunae and processes are in narrow canals called canaliculi, they are called osteocytes.



3- Osteocytes (mature cells):

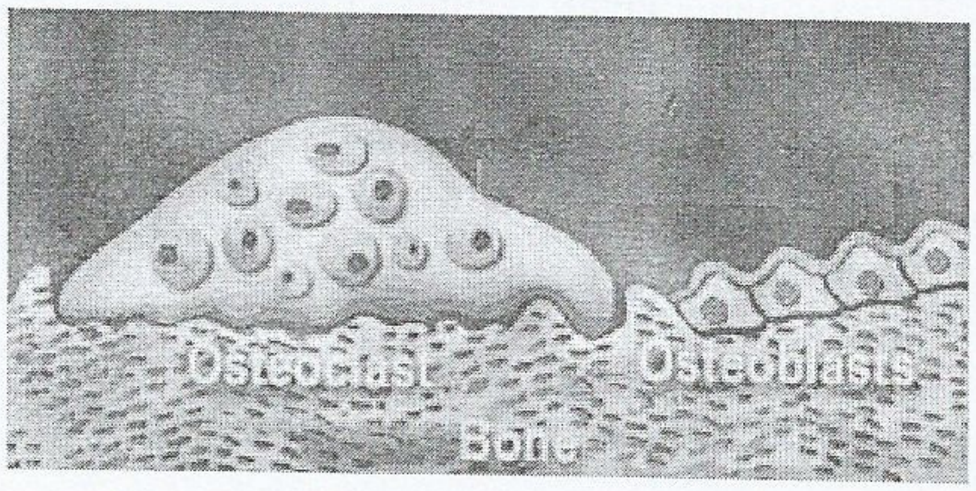
Origin: imprisoned mature osteoblast

Site: They are present inside lacunae, and are connected with one another by means of cellular processes passing through bone canaliculi which connect adjacent lacunae together

Structure:

LM: They are branched, ovoid cells, with an oval dark nucleus and basophilic cytoplasm, which is rich in alkaline phosphatase.

Function:



1-They preserve the integrity of the bone matrix and help to maintain its mineral content.
2-They are probably related to mobilization of calcium from the bone to the blood in times of need under hormonal effect (parathormone) through osteolysis

Osteoclasts (bone destruction cells)

Site: Are found on surfaces of bone where resorption is taking place, (i.e. in bone marrow spaces and in the medullary cavity).

Each cell resides on a shallow cavity on the bone surface called " Howship's lacuna"

Structure:

LM: The osteoclast is large, irregular in shape (20-30um) multinucleated cells

Cytoplasm: acidophilic duo to presence of acid phosphates, foamy and with striated or brush border facing the bone surface

Function:

They may be responsible for bone destruction or resorption

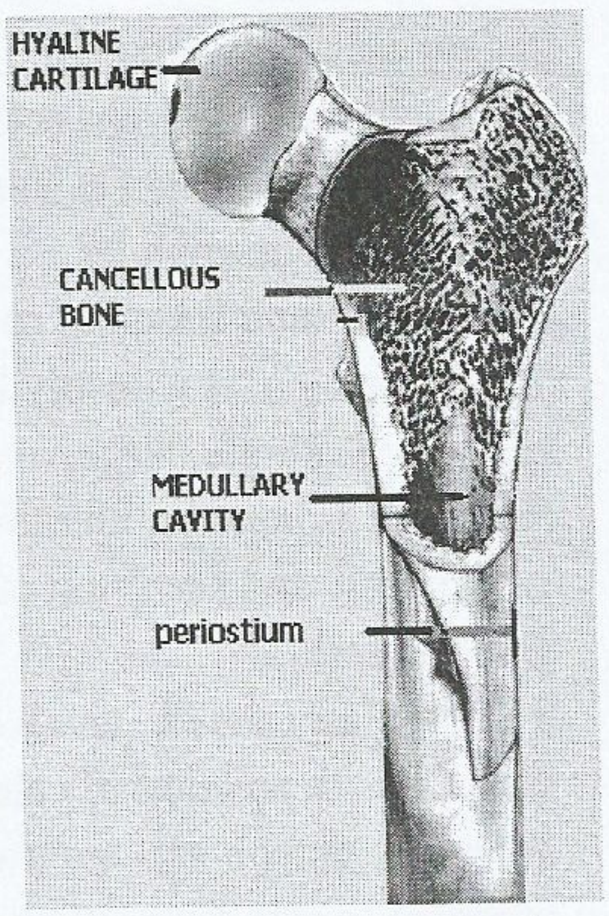
N.B: It is not phagocytic cells

A- Bone Fibers

These are type I collagen fibers:

a- calcified collagenous fibers: forming bone lamellae.

b- Perforating fibers of Sharpey's : extend from the periosteum to the external layers of the bone especially at the sites of attachment of tendons or ligaments fixing the periosteum to the bone.



B - Bone matrix:

Chemically formed of:

a- Organic substances : type I collagen (95%). It has ground substance that contains Chondroitin sulfate and keratin sulfate.
b- The inorganic portion of the bone matrix is composed of calcium, phosphate, bicarbonate, citrate, magnesium, potassium, and sodium.

Types of Bone :

A- Compact bone

B- Spongy or cancellous bone

PERIOSTEUM

It is a vascular connective tissue membrane covering the bone from outside.

It is formed of two layers:

1-Outer fibrous layer: rich in blood vessels and nerves.

2-Inner osteogenic layer: this (in the resting condition) is formed of osteogenic cells). When stimulated (e.g. during growth, or fracture) these cells can change to osteoblasts.

Function:

1- Its fibrous layer:

a- provides attachment to tendon, ligaments, and muscles,

b- Supplies blood vessels which carry the oxygen and nourishment to the bone.

2- Its osteogenic layer: contains the osteogenic cells which (when activated) can proliferate and differentiate into osteoblasts to lay down bone. This layer is, therefore, responsible for:

a- growth of bone by apposition (i.e. subperiosteal deposition of bone which causes growth of the bone in width),

b- healing and regeneration of bone after injury or fractures.

ENDOSTEUM

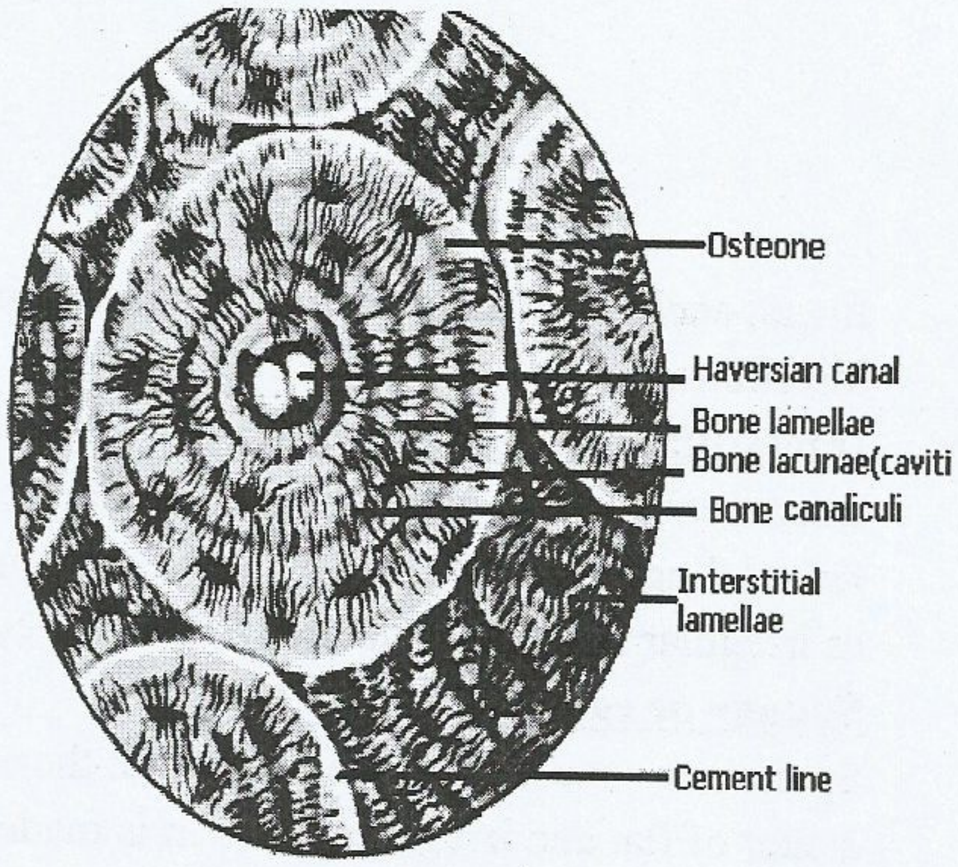
The endosteum is a loose layer of C.T. membrane and rich in osteogenic cells which lines bone cavities and covers bone trabeculae.

Function:

a- it is supplied bone with blood and nutrition.

b- Its osteogenic cells, osteoblast cells and osteoclast cells are concerned with bone formation during growth of bone lamellar (mature) bone orcompact bone

Compact bone is a solid mass in the shafts of long bones. It is also found as a thin plat covering flat irregular bones.



Bone lamellae are regularly arranged:

1- Haversian systems or osteons.

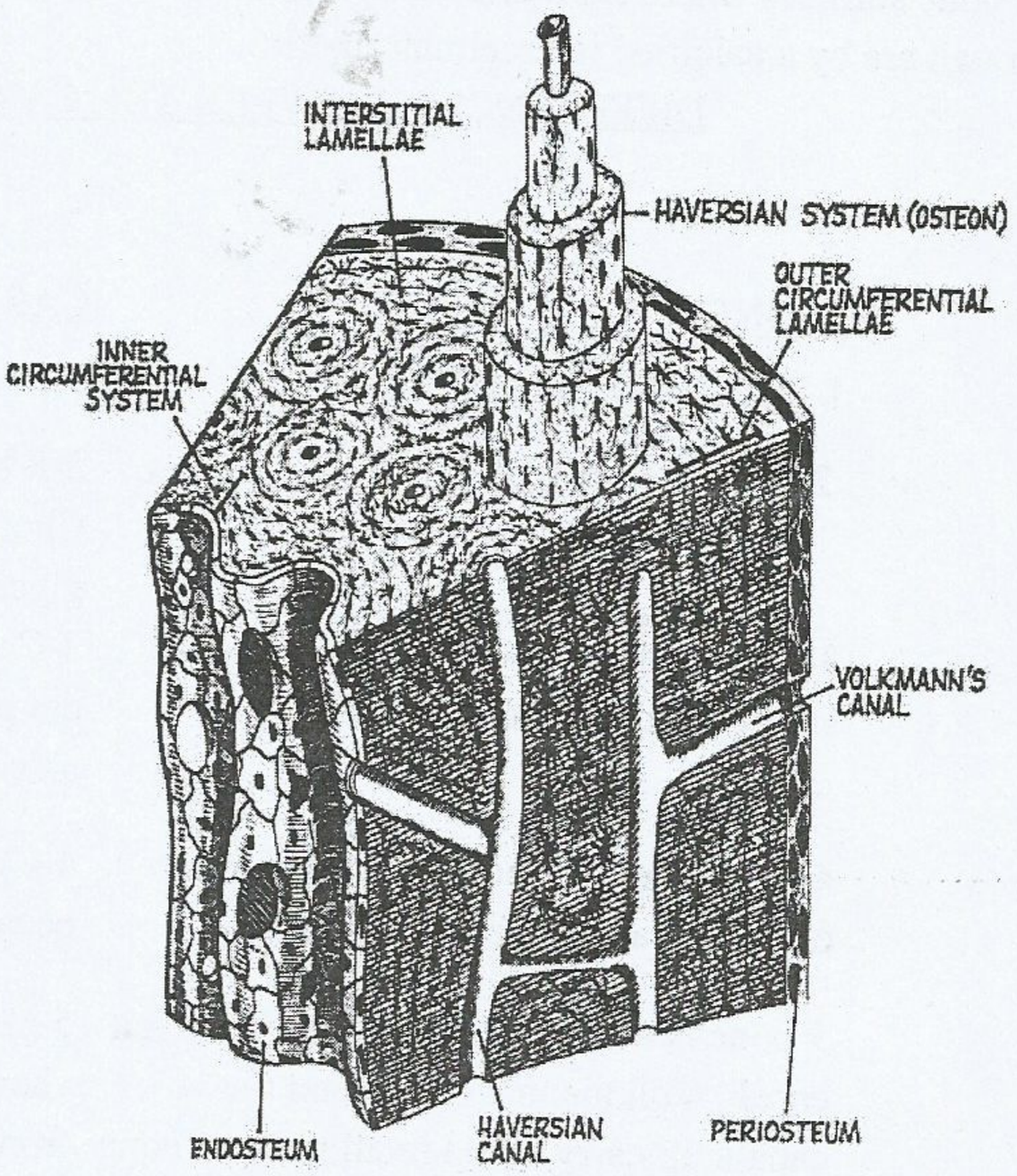
2- Interstitial lamellae: between Haversian systems.

3- Outer and inner circumferential lamellae under periosteum and endosteum.

<u>Osteons (Haversian Systems):</u>

are cylindrical structures of compact bone, which in transverse section are seen to be formed of 4-20 regular concentric lamella surrounding a central vascularchannel (Haversian canal).

At the periphery of each osteon, and separating it from adjacent osteons or interstitial systems, is a cement line. The cement lines do not calcify, have relatively little collagen, but are rich in Glycoproteins and stain differently from the matrix of lamella



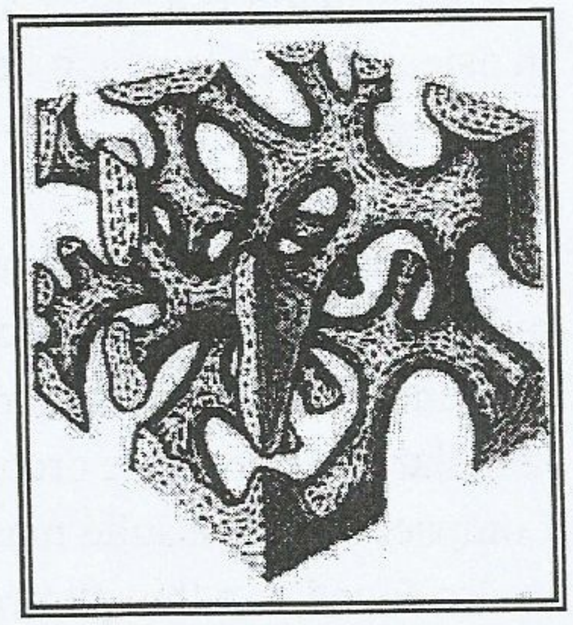
OSTEONS represent the main morphofunctional unit of compact bone.

The blood vessels of the Haversian canals are supplied with blood from vessels from the periosteum. These blood vessels penetrate the osteons in a transverse direction and are known as Volkmann's canals. Volkmann's canals can be identified as they do not have concentric lamella surrounding them.

<u>Circumferential Systems:</u>

Immediately below the periosteum, at the periphery of compact bone of the diaphysis, the lamellae surround the bone in a continuous manner. These are known as the outer circumferential lamellae. A similar system of continuous lamellae adjacent to the endosteum is also found and is known as the inner circumferential lamellae. Bundles of collagen fibers, known as Sharpey's fibers or perforating

fibers, anchor the periosteum to the outer circumferential lamellae, especially in sites of tendon insertions.



Interstitial lamellae Systems:

Interstitial systems of compact bone represent the remnants of osteons after remodeling. They are present between regular osteons and can be identified as irregular lamellar structures that lack a central Haversian canal.

Spongy or cancellous bone :

Spongy or cancellous bone is found at the ends of long bones and in the center of flat and irregular bones .it is made up of branching trabeculae, each of which is composed of irregular lamellae. There are no Haversian systems.

BLOOD CIRCULATION IN COMPACT BONE:

1- Bone is vascular, richly supplied with capillaries which are carried in Haversian and Volkmann's canals.

2- Bone has a canalicular system which extends from one lacuna to another and to Haversian canals or bone surfaces where capillaries are present. By this mechanism bone cells gets nutrients even though are by a calcified intercellular matrix.

DIFFERENCES BETWEEN THE CARTILAGE AND BONE

BONE	CARTILAGE
1-It is a solid inflexible tissue	1-It is a rigid flexible tissue
2-It has a solid matrix rich in Calcium.	2-It has a rigid matrix rich in Chondroitin sulpheric acid and glycoprotein
3- Bone cells (osteocytes) are present singly inside lacunae	3-Cartilage cells (Chondrocytes) are present singly or in groups in side lacunae forming cell nests
4-Osteocyes intercommunicate by the canaliculi arising from their lacunae.	4-Chodrocytes do not communicate because there are no canaliculi
5-bone is a vascular tissue, its Haversian canal , Volkmann's canals and the canaliculi carry blood to all parts of bone	5-Cartilage is avascular tissue but its chondrocytes receive nourishment from B.V. of the perichondrium
6- osteocytes cannot divide	6-chondrocytes can divide

PERIPHERAL BLOOD

Blood consists of:

(a) Formed elements (cells and platelets)

(b) Plasma (liquid component in which the formed elements are suspended).

Plasma is an aqueous solution containing proteins (7%), lipoproteins (10%), amino-acids, vitamins, hormones, and inorganic salts. The main blood proteins are:

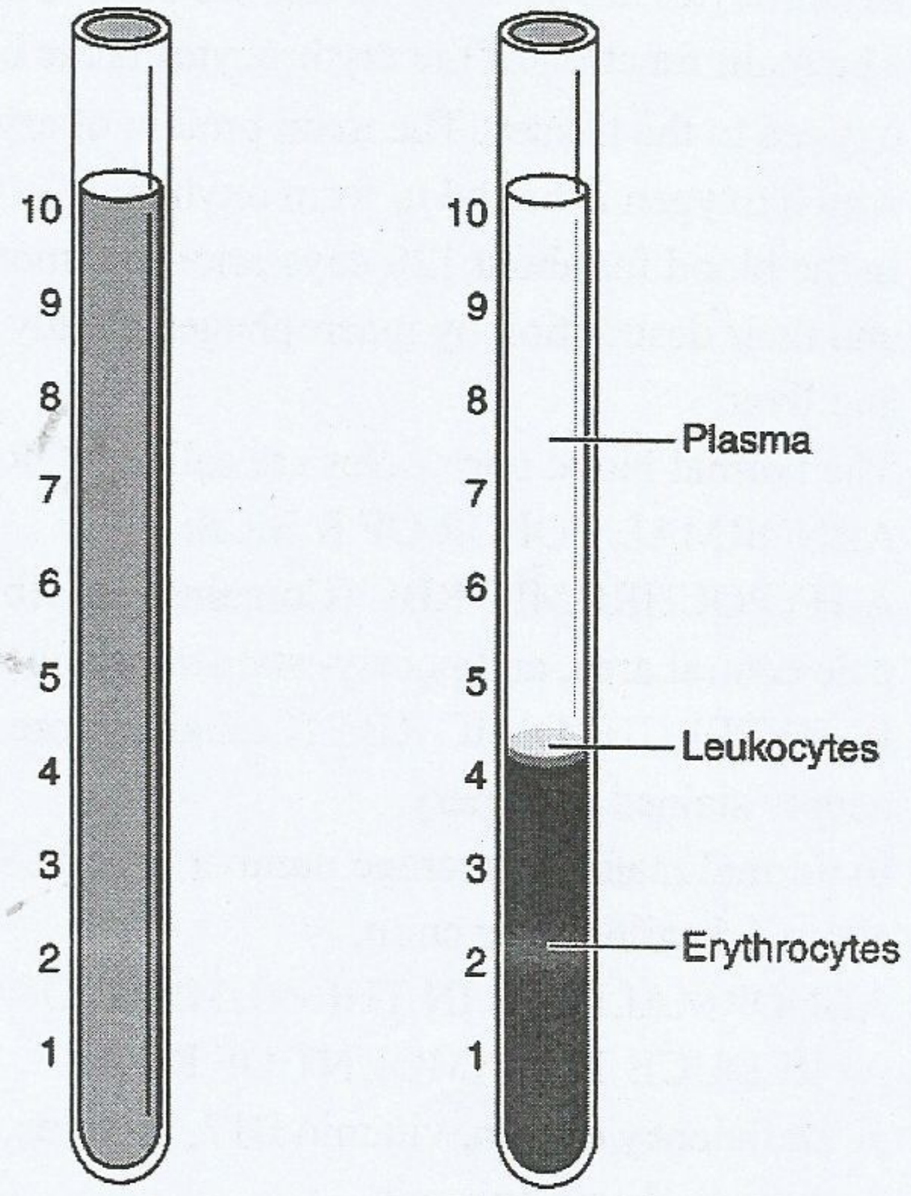
(a) albumins (maintains osmotic pressure of blood)

(b) gamma globulins (immunoglobulins or antibodies)

c) fibrinogen (clotting agent)

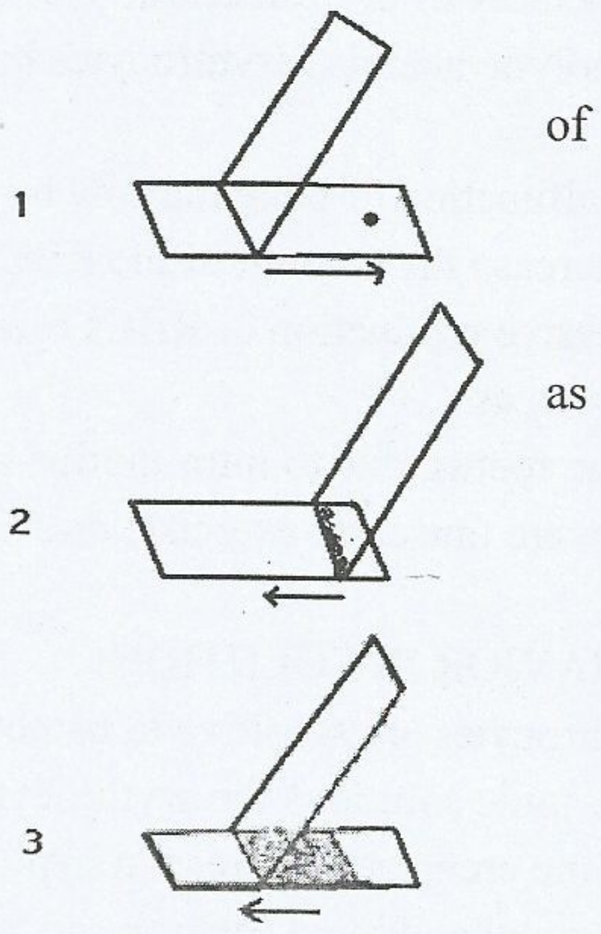
If blood is allowed to clot, the clot contains the formed elements, whereas the clear yellow liquid that separates is known as the serum. Serum is similar to plasma but lacks fibrinogen and other clotting agents.

If a test-tube of blood is centrifuged it separates into several distinct layers. The lowest layer, which is an orange or reddish color, contains the erythrocytes (about 45% of the volume). A thin layer (1%) known as the buffy coat is located above the layer of erythrocytes. This contains the leukocytes and platelets. The remaining upper clear fluid is the plasma (about 55%). The relative volumes of cells and plasma are described as the "hematocrit". Low hematocrit values can indicate blood disorders such as anemia.



Blood smears:

A drop of blood spread thinly on a microscope slide and dried is known as a blood smear. In order to provide contrast and distinguish the various cell types (formed elements) the smear is stained. The various common blood staining techniques (Leishman, Giemsa) are all modifications of the Romanovsky (1891) staining method based on mixtures of methylene blue (basic dye) and eosin (acid dye). The methylene blue is oxidized by certain components to form azures (purple color), and the structures stained are described as azurophilic. Affinity for eosin is termed eosinophilia or acidophilia.



Formed elements of the blood :

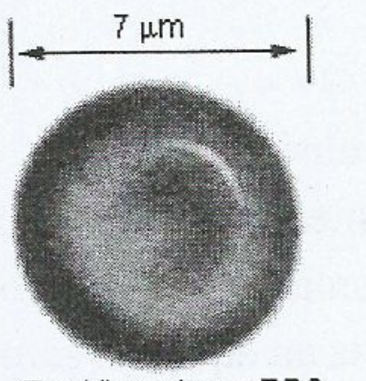
1- Erythrocytes (red blood cells)

2- Leukocytes (white blood cells)

3- Platelets

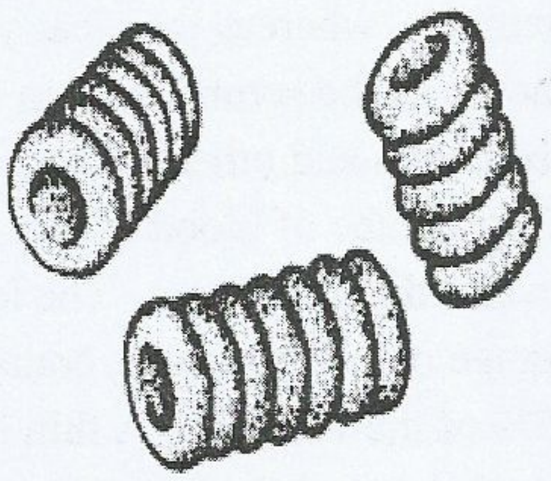
Erythrocytes:

The erythrocytes of mammals lack nuclei (apart from in the fetus).
Human erythrocytes are biconcave discs about 7.2μm diameter (similar to the dimensions of most capillaries). Abnormal variation in size is known as anisocytosis. Abnormal variation in shape is known as poikilocytosis. Erythrocytes are fairly flexible and can modify their shape to pass bends in the capillaries. Erythrocytes transported in the blood often appear bound together in "rouleaux", similar to stacks of coins.
Erythrocytes are acidophilic and are stained a reddish color with eosin.
The main function of the erythrocytes is the binding and transport of oxygen to the tissues. The main protein of erythrocytes is hemoglobin, to which oxygen is bound to form oxyhemoglobin. Erythrocytes circulate in the blood for about 120 days prior to removal of the aged erythrocytes and their destruction by macrophages mainly in the spleen and liver.



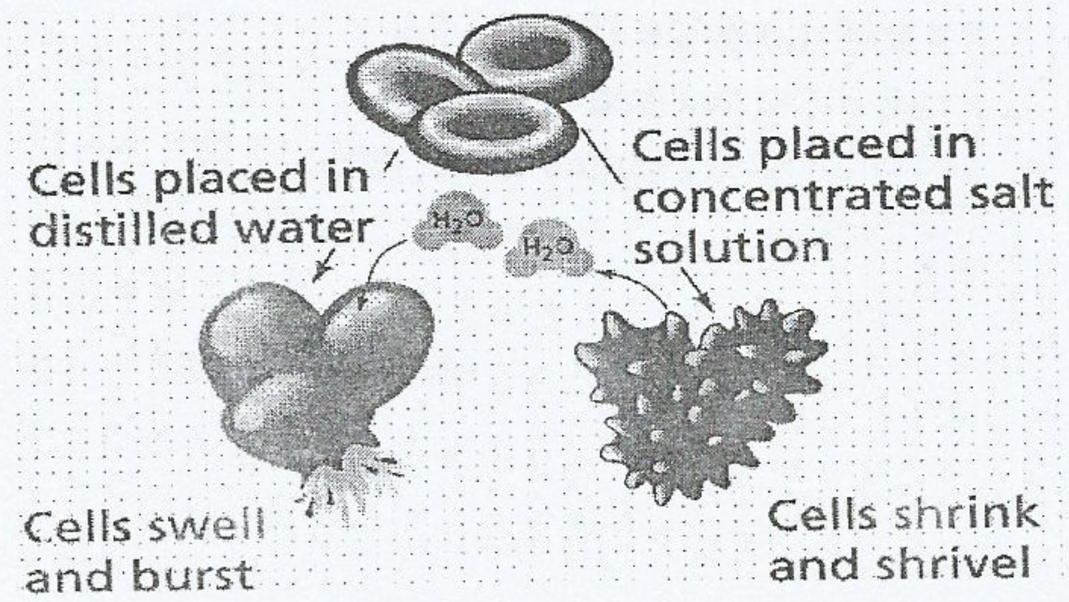
Top View shows RBC to be circular


Side view shows RBC to be a biconcaved disc

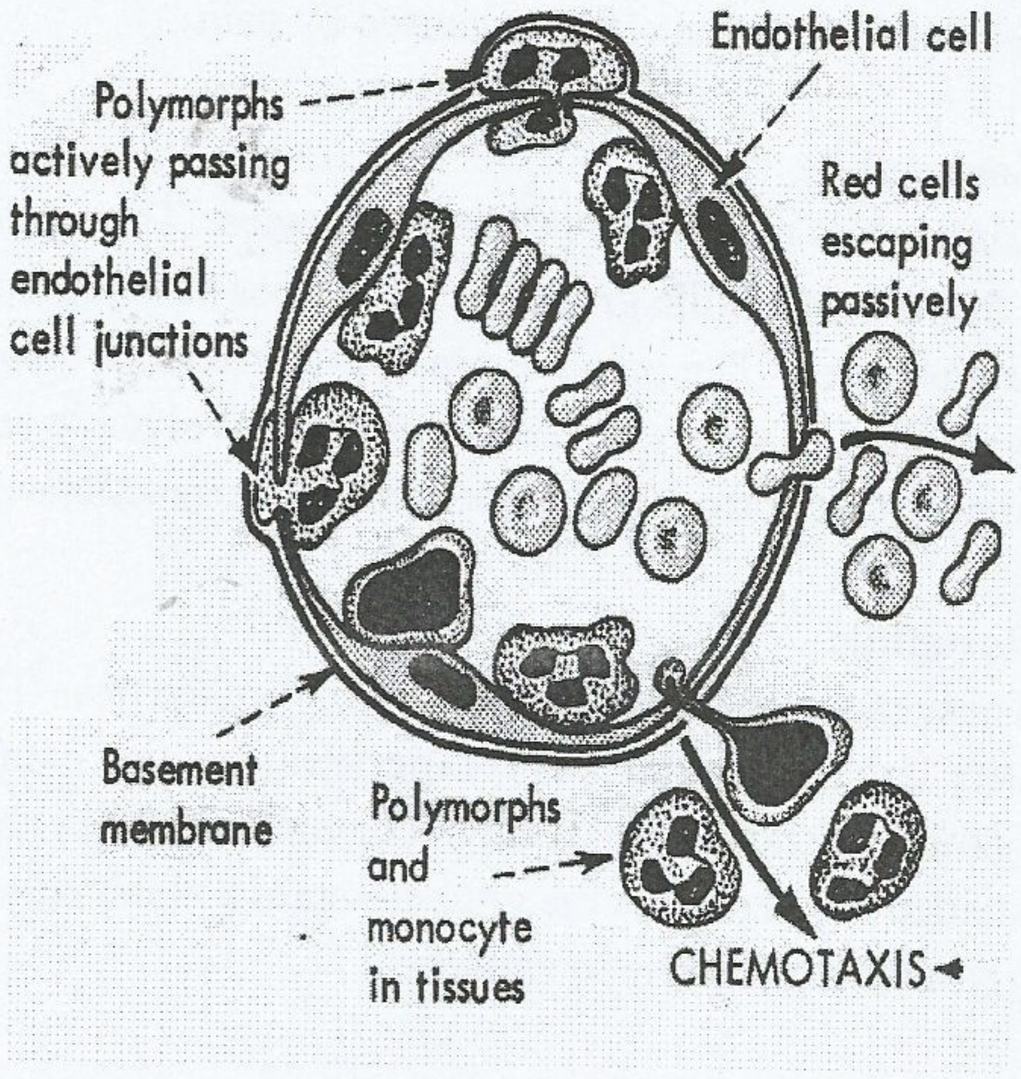


The normal blood corpuscles are called NORMOCHROMIC.
ABNORMAL COLOR OF R.B.CS:
A-HYPOCHROMIC RBC (Contains less Hb% than usual). It has a larger pale central area, and poorly- stained periphery .
B- HYPERCHROMIC RBC (Contains more Hb% than usual) It has stained central area, and a deeply stained periphery.
In normal male the average number of RBCS is about 5 million per cubic millimeter. In female it is about 4.5 million per cmm.
ABNORMALITIES IN THE NUMBER OF RBCS:.
A- REDUCE THE AMOUNT OF RBCs
1- Deficiency of iron, vitamin B12, proteins, vitamin C, copper, calcium (i.e. deficiency anaemia).
2- haemorrhagic anaemia
3- Haemolysis or destruction of RBCs. e.g. in increased fragility of RBCs or by bacterial toxins (i.e. haemolytic anemia) erythrocytes have the shape of elongated crescents (sickles) due to of abnormal Hb.
4- Malfunction of bone marrow by various exogenous or endogenous causes a plastic anaemia
B- increase the amount of the RBCs Polycythaemia
Excessive production of RBCs from the bone marrow due to hypoxia which stimulates the bone marrow, as
a- The foetus, due to intra-uterine anoxia
e- Severe muscular exercise, due to excessive need of oxygen by the tissues

BEHAVIOR IN SOLUTION:
Erythrocytes are sensitive to osmotic pressure. In hypertonic solutions the erythrocytes shrink and become crenated, whereas in hypotonic solutions they swell and burst (hemolysis) leaving membrane "ghosts".

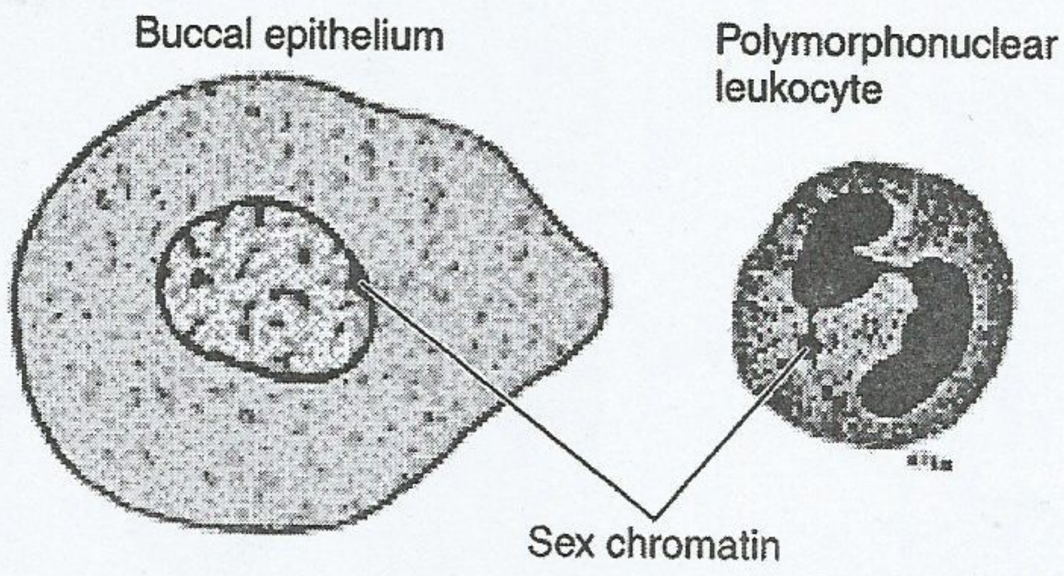


Leukocytes (white blood cells):The leukocytes are involved in the defense of the body and participate in protection against foreign material including microorganisms.
IN NORMAL ADULT THE "TOTAL LEUKOCYTIC COUNT "IS BETWEEN 4,000- 10,000 PER CUBIC MILLIMETER
The leukocytes are classified into two major groups:
(a) Granulocytes)
1- Neutrophils 60-75 %
2- Eosinphils 2-4 %
3- Basophils 0- 0.5 %
(b) Agranulocytes (Lymphocytes, Monocytes)
1- Lymphocytes 20-40 %
2- monocytes 3- 8 %
Granulocytes are characterized by:
(i) irregular segmented nuclei
(ii) specific granules (specific size, staining affinities)
(iii) terminal (fully differentiated) cells.
Agranulocytes are characterized by:
(i) regular nuclei (round or kidney-shaped)
(ii) non-specific granules (also present in other leukocytes)
Leukocytes can leave the blood circulatory system and enter connective tissue, where they mostly function. This ability to cross the capillary walls is known as diapedesis. This migration of leukocytes from capillaries into the connective tissue is important in tissue responses to injury. The leukocytes do not return to the blood, with the exception of lymphocytes (recirculation).



GRANULOCYTES

Neutrophils : also known as polymorphonuclear leukocytes or polymorphs, are the most common of the leukocytes and represent some 55-70% of all the circulating leukocytes. They have a diameter of about 12μm and are characterized by a segmented nucleus. In females a small "drumstick" is found (Barr's body) on the nucleus representing a condensation of the sex-chromatin. The cytoplasm of neutrophils is packed with small specific granules stained a salmon pink color in smears after Romanovsky-type staining. Some specific granules contain phagocytins, which are anti-bacterial substances involved intracellular

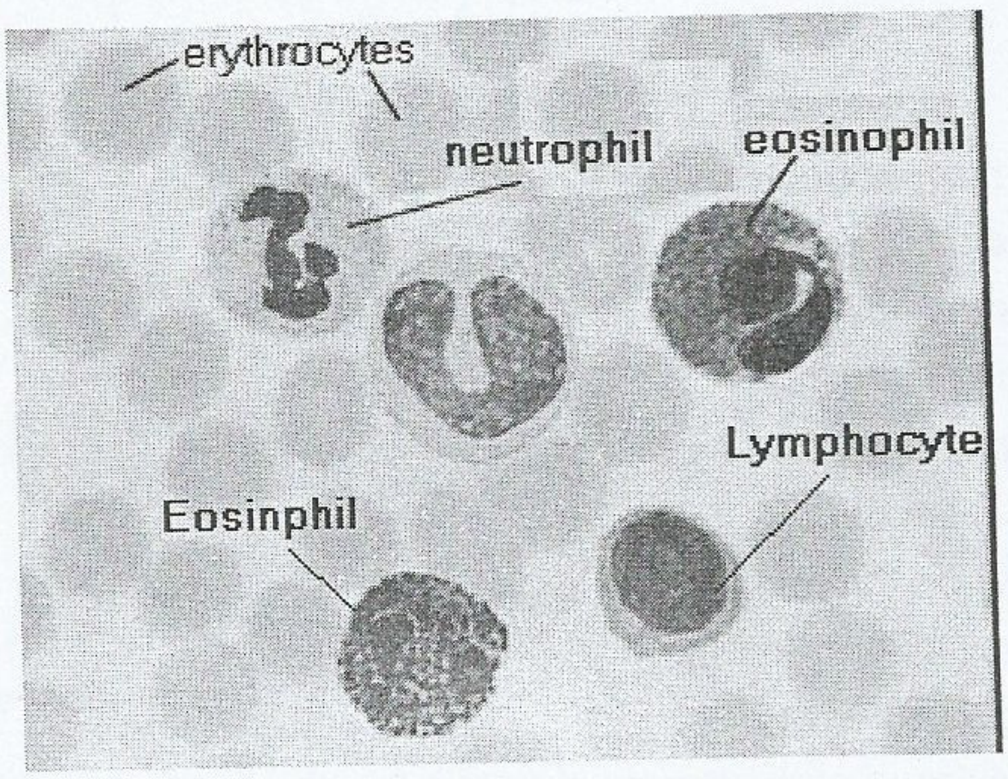


digestion. The non-specific granules (stained weakly azurophilic) contain lysosomal enzymes and peroxidase.
Neutrophils are phagocytic cells involved as a first line of defense against invading microorganisms. They are important in inflammation and at sites of injury or wounds. Pus that develops in sites of infection is mainly composed of dead neutrophils.

The clinical signs of acute inflammation
1- Swelling :This localized Odem or increase fluid in amorphous material of connective tissue is responsible for the swelling at site of acute inflammation.
2- Redness and hotness: histamine causes dilatation of arterioles and capillaries . this dilatation causes increased blood flow and is responsible for the redness and hotness.
3- Pain This is caused by the pressure of the increased amounts of the tissue fluid on the sensitive sensory nerve endings.
4- Loss of function : this is caused by pain

Eosinophils
Eosinophils represent 1-4% of leukocytes. They typically have **bilobed nuclei** and fairly large (0.5-1.5μm) **acidophilic granules**. The color of the granules in stained smears is similar to that of erythrocytes. The granules are considered to be **lysosomes** and contain acid phosphatase, and other lysosomal enzymes.). Eosinophils are involved in selective phagocytosis. An increase in the numbers of eosinophils is seen in allergic reactions or helminthes parasitic infections.

Basophils
These represent only about 1% of the leukocytes. Their nucleus is bilobed or S-shaped. They have very large, **irregular basophilic granules**, that commonly obscure the nucleus. The granules (similar to those of mast cells) contain **histamine** and **heparin** and show metachromatic staining. In stained blood smears the granules stain a violet color. Basophils release the contents of their granules in response to antigens.



AGRANULOCYTES

Lymphocytes

Lymphocytes represent 25-30% of all the leukocytes. Lymphocytes are involved in the immune responses of the body. The most common lymphocytes are small cells (6-8μm diameter), with very dense regular nuclei, with relatively little cytoplasm. The different types of lymphocytes are considered in the framework of the lymphatic system.

Monocytes

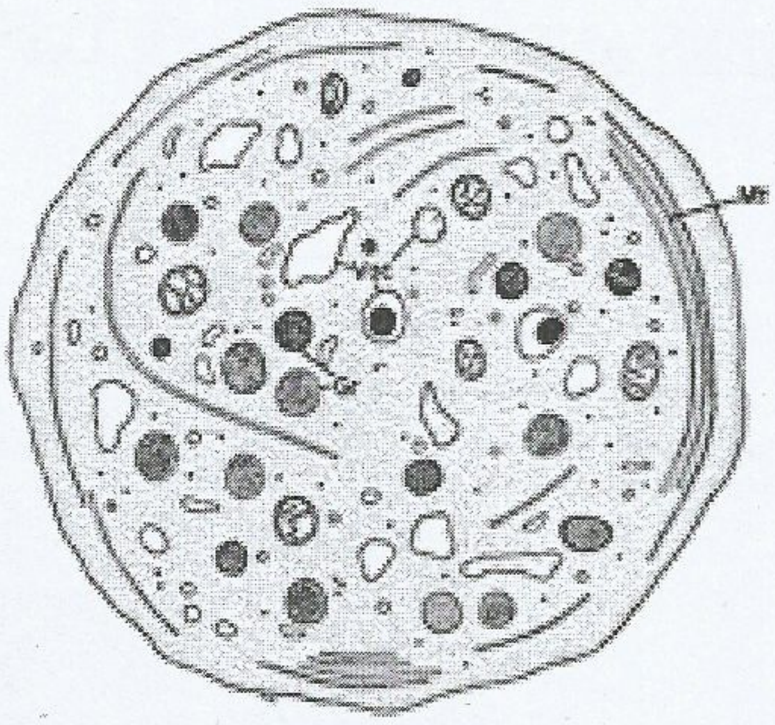
Monocytes represent about 5% of the leukocytes. They possess oval or kidney-shaped nuclei, often eccentrically located. The nuclei are less intensely stained than those of lymphocytes. The cytoplasm is basophilic with small azurophilic granules (lysosomes). Monocytes are part of the **Mononuclear Phagocyte System**. They are non-terminal cells and can differentiate into phagocytic cells such as macrophages. Monocytes that enter the tissues do not return to the blood.

Blood platelets

number: 250,000-350,000/cubic mm.

Blood platelets are derived from the cytoplasm of megakaryocytes of the bone marrow. They are small (2-5μm) with a central core of small purple granules (granulomere) surrounded by an outer pale-blue hyalomere. At the periphery (as seen by electron microscopy) there are peripheral or marginal microtubules.

If a blood vessel is injured, the platelets are involved in the clotting reaction. They aggregate at the site of injury, change shape and help form the thrombus.



Muscle tissue

GENERAL CHARACTERISTICS OF MUSCULSR TISSUE

1- Muscle tissue is composed of cells that show great development of contractility and conductivity.
2-Muscle cells: are called (myocyte) which are elongated in one direction so, they are referred to as (muscle fibers).
3-The plasma membrane of the muscle fiber is called "sarcolemma"
4-The cytoplasm of the muscle fiber is called sarcoplasm (sarkos ,flesh). It contains glycogen, Fat and myohaemoglobin (myoglobin) pigment, beside the organoids (sarcosome or mitochondria, and Myofilaments and myofibrils (contractile elements).
5- Muscle fibers are called "striated" or "non-striated" according to whether, or not, they show transverse striations
6- Muscle fibers may be" voluntary" (when contraction is under the control of will), or "involuntary" (when it is beyond the control of will
7- Muscle fibers are mesodermal in origin, except the muscles of iris, and myoepithelial cells around the acini which are ectodermal.
8- Muscle fibers are the three types: 1) the skeletal muscle, 2) the cardiac muscle and 3) the smooth muscle.

Types of muscle:-

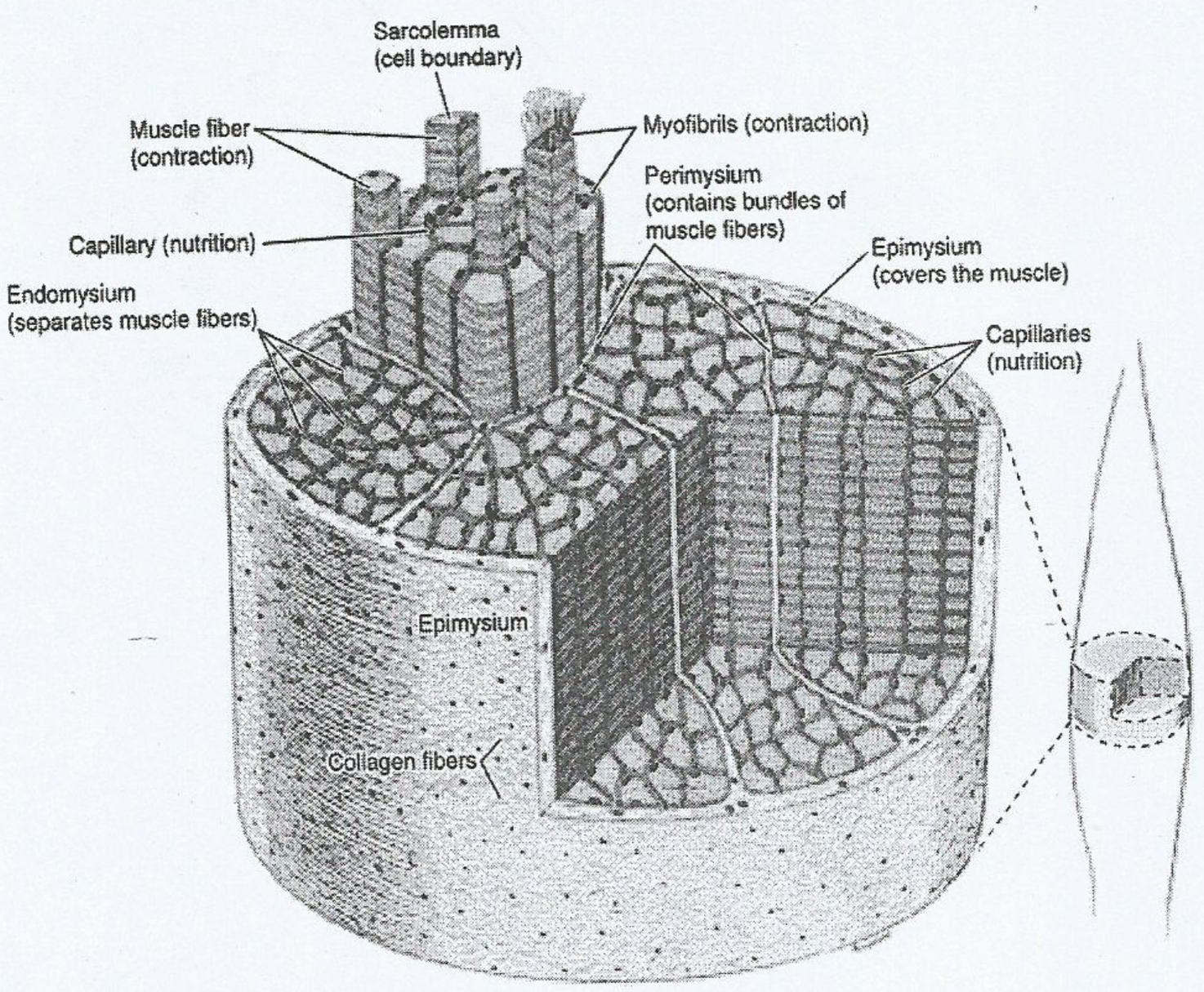
Skeletal muscle

Smooth muscle

Cardiac muscle

RELATION OF MUSCLE FIBERS AND CONNECTIVE TISSUE

The whole muscle is surrounded by a membrane of fibrous tissue called the epimysium which sends septa to divide the muscle into bundles, these septa are known as the perimysium which turned sends fine septa surrounding individual muscle fibers known as the Endomysium.



Functions of connective of tissue of the muscle:

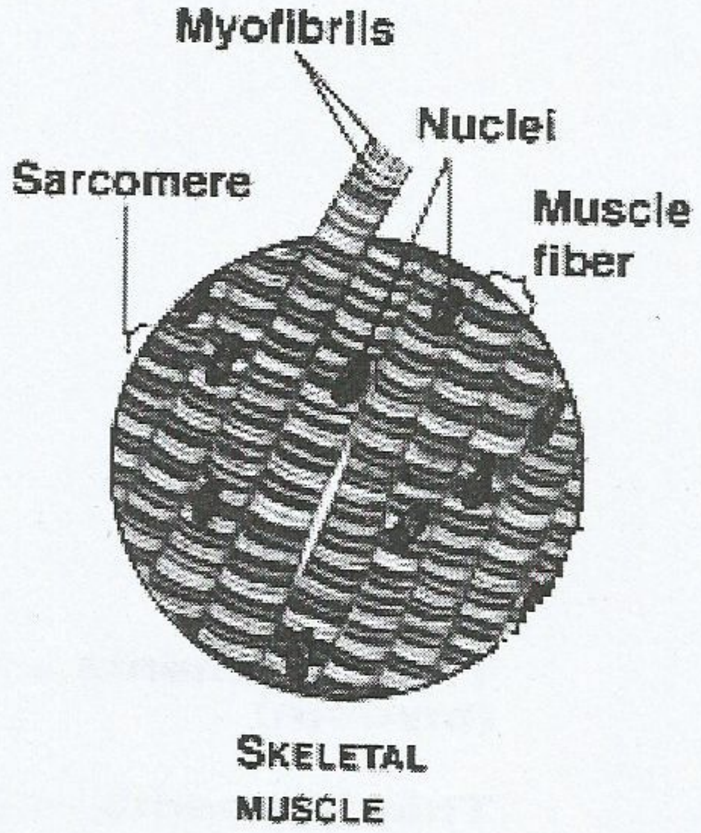
1-Good blood supply with food, O2 and remove waste products is offer by blood vessel that runs through C.T with nerve and lymphatic vessels

2- It firmly attaches the muscle bundles together

3- It acts as an equipment by which the muscle is firmly attached to, and continuous with, a tendon, ligament, aponeurosi, or periosteum etc

Types of skeletal muscle:-

- Red:- reddish in color which contract slowly (slow twitch).
- White:- whitish in color which contract faster (fast twitch).



SKELETAL MUSCLE

Structure of skeletal muscle:

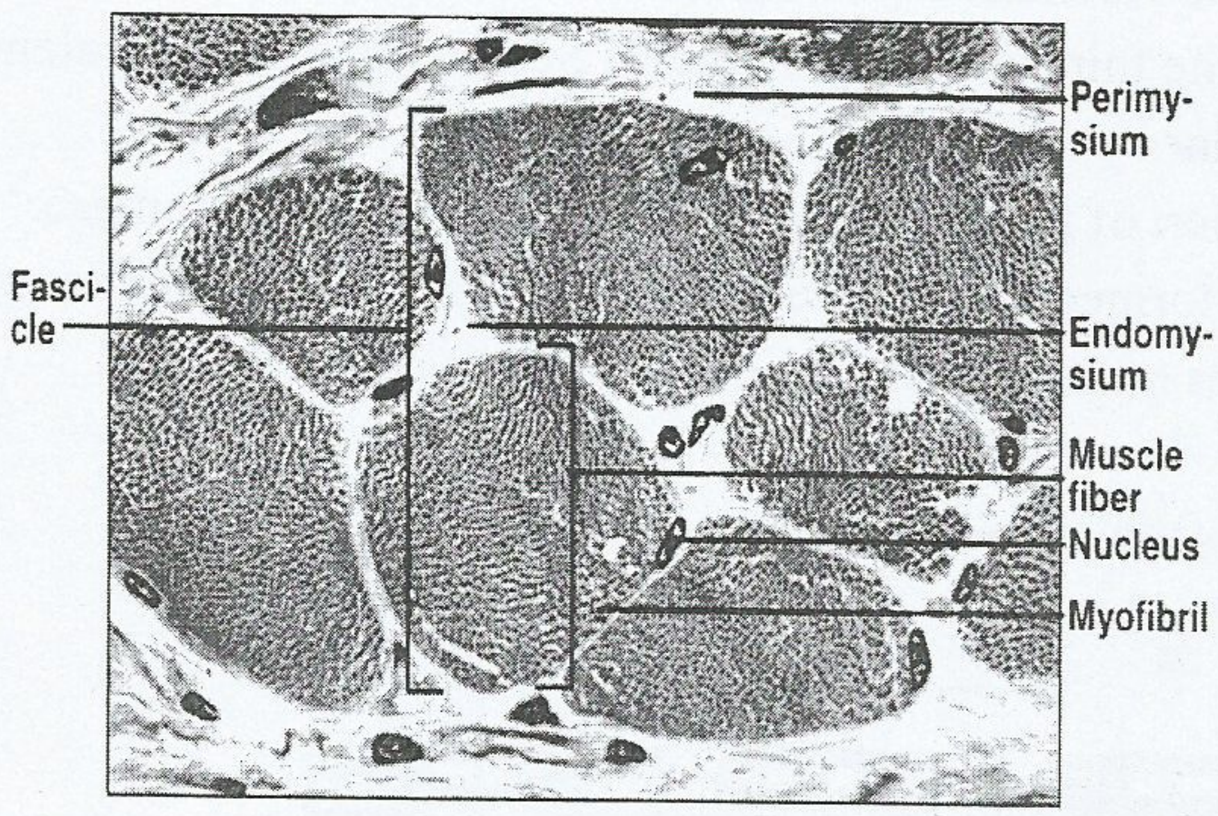
By light microscope:

- each is an elongated cylindrical shaped fiber. It may vary in length from one mm- up to 4 cms, or even more and from 10 up to 100 micron in thickness.
- multinucleated cells with oval nuclei located periphery under the cell membrane.
- Their sarcoplasm shows transverse striations hence their name; striated . The striation are due to the presence of myofibrils in their sarcoplasm.

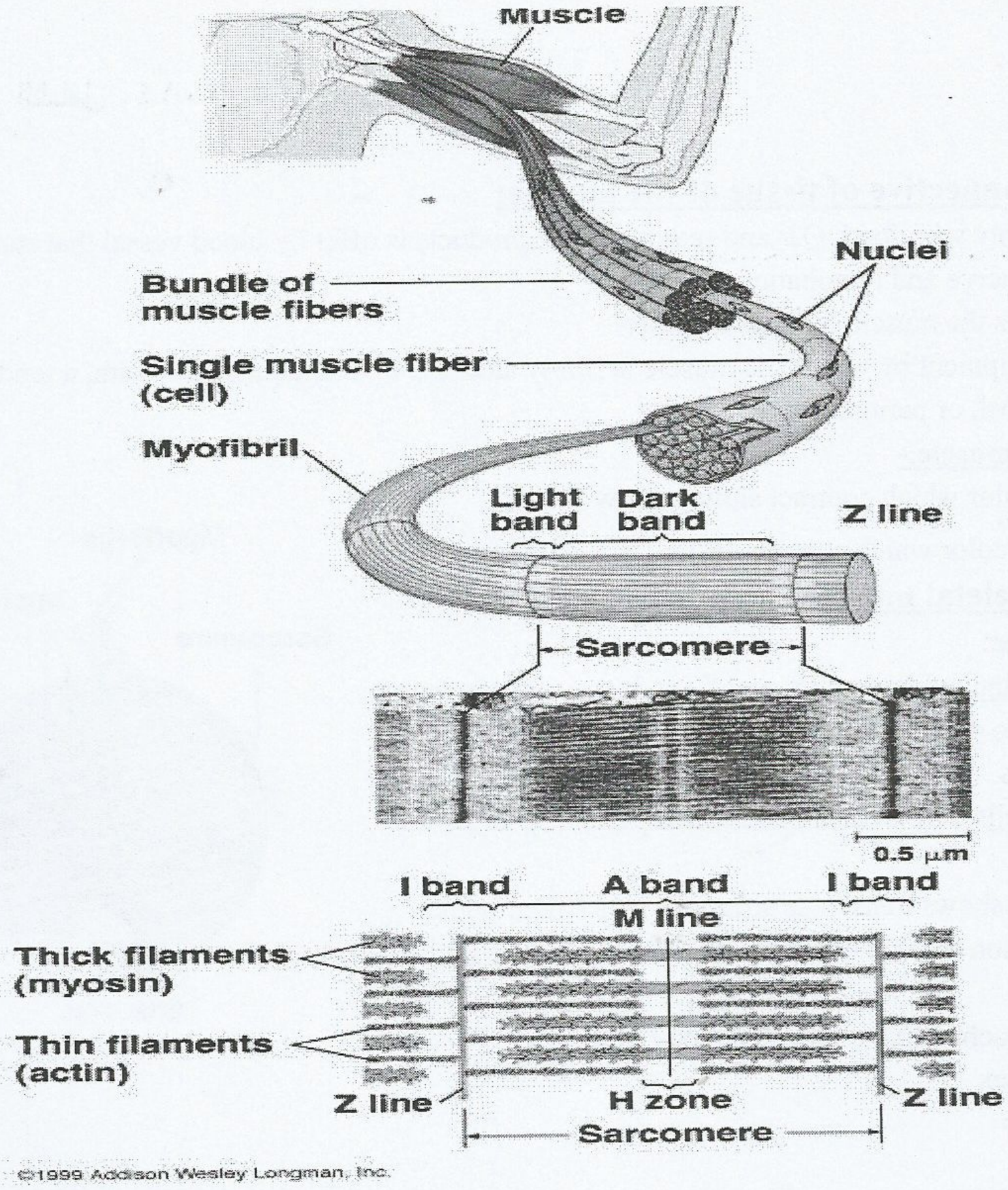
Sarcosome: or mitochondria are located near the nuclei.

- Small Golgi complex .
- Some lipid droplets.
- Glycogen.
- Sarcoplasmic reticulum.
-

Fascicle and Perimysium



Striated muscle voluntary (skeletal)muscle T.S



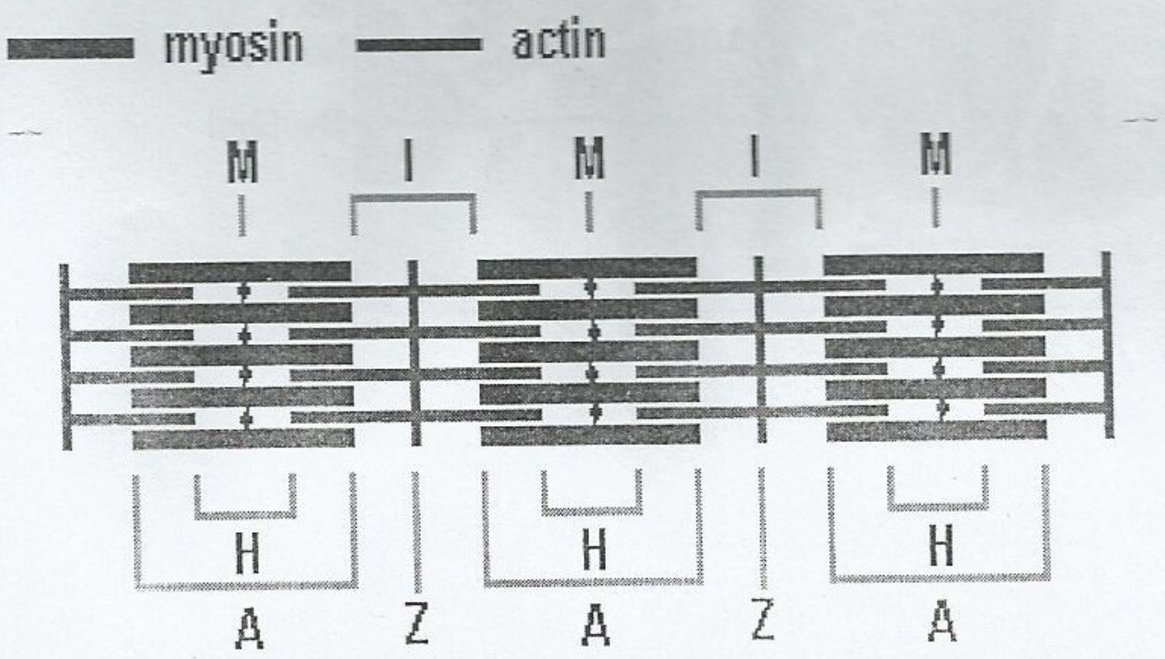
The invaginations of the T system between the A and I bands twice in every sarcomere.

- terminal cisternae of the sarcoplasmic reticulum (SR), forming triads. Abundant mitochondria lie between the myofibrils.

-myofibrils shows the thin and thick filaments Surrounding the sarcolemma are a basal lamina and reticular.

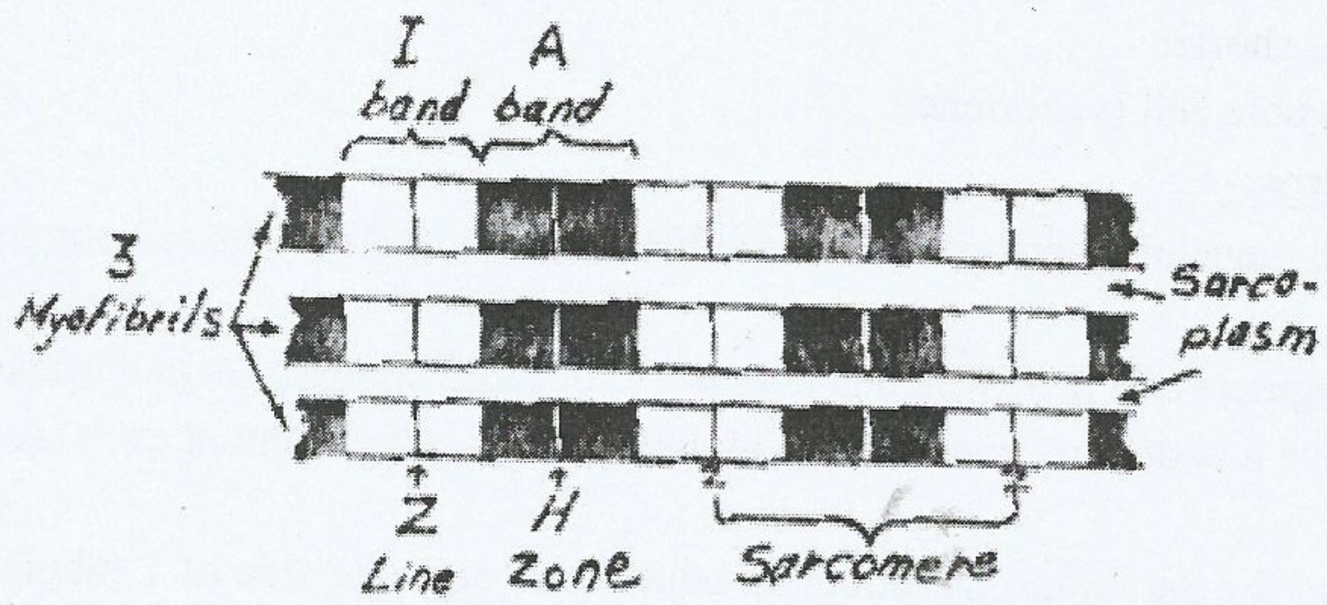
Structure and position of the thick and thin filaments in the sarcomere:

The myofibrils are formed of more delicate filaments called "myofilaments" There are two different types of myofilaments [coarse (thick) and fine (thin).

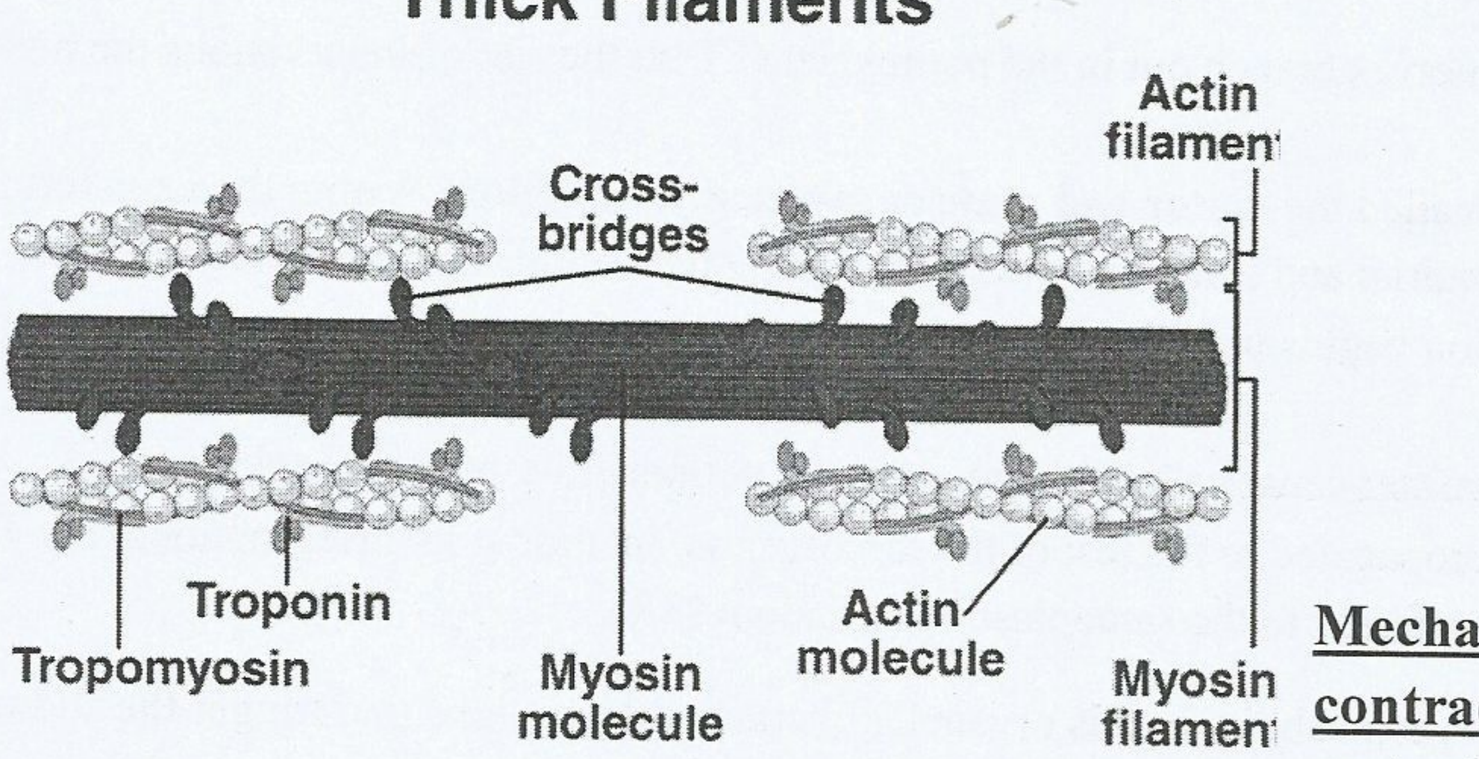


Bands and lines in the contractile apparatus of skeletal muscle

-The «dark» area of the myofibril is called the" A" band.
- The «light» area is called the" I" band.
- Hensen's zone or "H" zone is a pale region in the middle of the "A" bands
- Krause's membrane or the "Z" line divides the I band into 2 equal halves.
-The part of the myofibril which lies between two Z lines is called “Sarcomere”

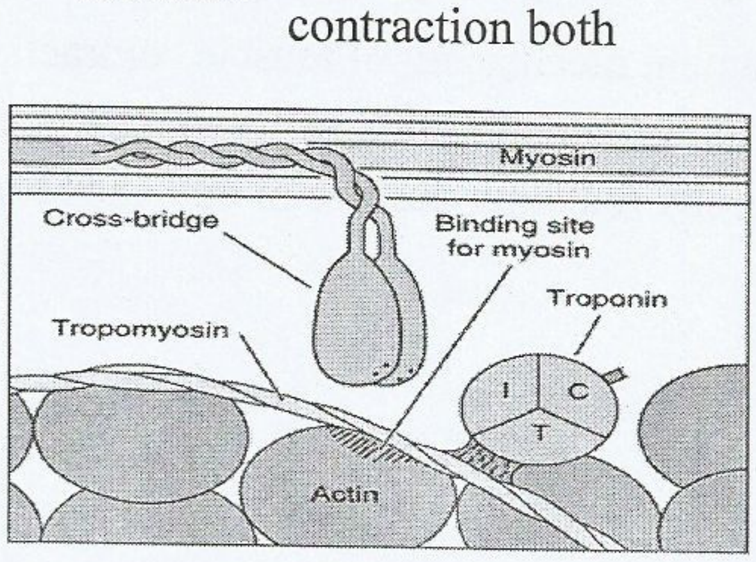


Molecular structue of myofiberiles:



Mechanism of contraction

-During contraction both myosin and actin filaments retain their original length.
-Contraction result of an increase in amount of over lap between the filaments.
-The energy ATP that require by the mechanism are obtain from sarcosomes.
-All myofibrils contract at the same time, starting at the (A-I) band junction.



- Power of contraction varies by the number of muscle units that contract.

Summarizing during contraction:

Thin (actin) filaments slide pass thick (myosin) filaments.

-Decrease width of I band.

-Decrease width of H band.

-Z lines are closer to each other.

-A band remains constant.

-Sarcomeres become shorter.

-Consequently the whole cell is shortened.

Membrane systems:-

-The SR consist of a branching network of smooth ER cisternae and tubules surrounding each myofibril.

SR function is to regulate ca+ flow which is necessary for rapid contraction and relaxation cycles.

-Skeletal muscle have a system of transverse (T) tubules which are present at each (A-I) junction in every myofibril.

-Terminal cisterna of the Sarcoplasmic reticulum adjacent to opposite side of T tubules.

-Complex of "a terminal cisternae + T tubules+ terminal cisternae'' called triad.

-Depolarization is initiated at myoneural junction on the T tubule, terminal cisternae and branching net work of the sarcoplasmic reticulum where ca+ are released around myofibrils initiating the sliding of thin filaments B/ W the thick filaments.

INNERVATION:

Myelinated motor nerves branch out in the perimysial C.T .at the site of innervations the nerve loses its myelin sheath.

♦This structure is called the **motor end plate** or **myoneural junction**. Within the axon terminal are numerous mitochondrial and synaptic vesicle containing the neurotransmitter acetylcholine.

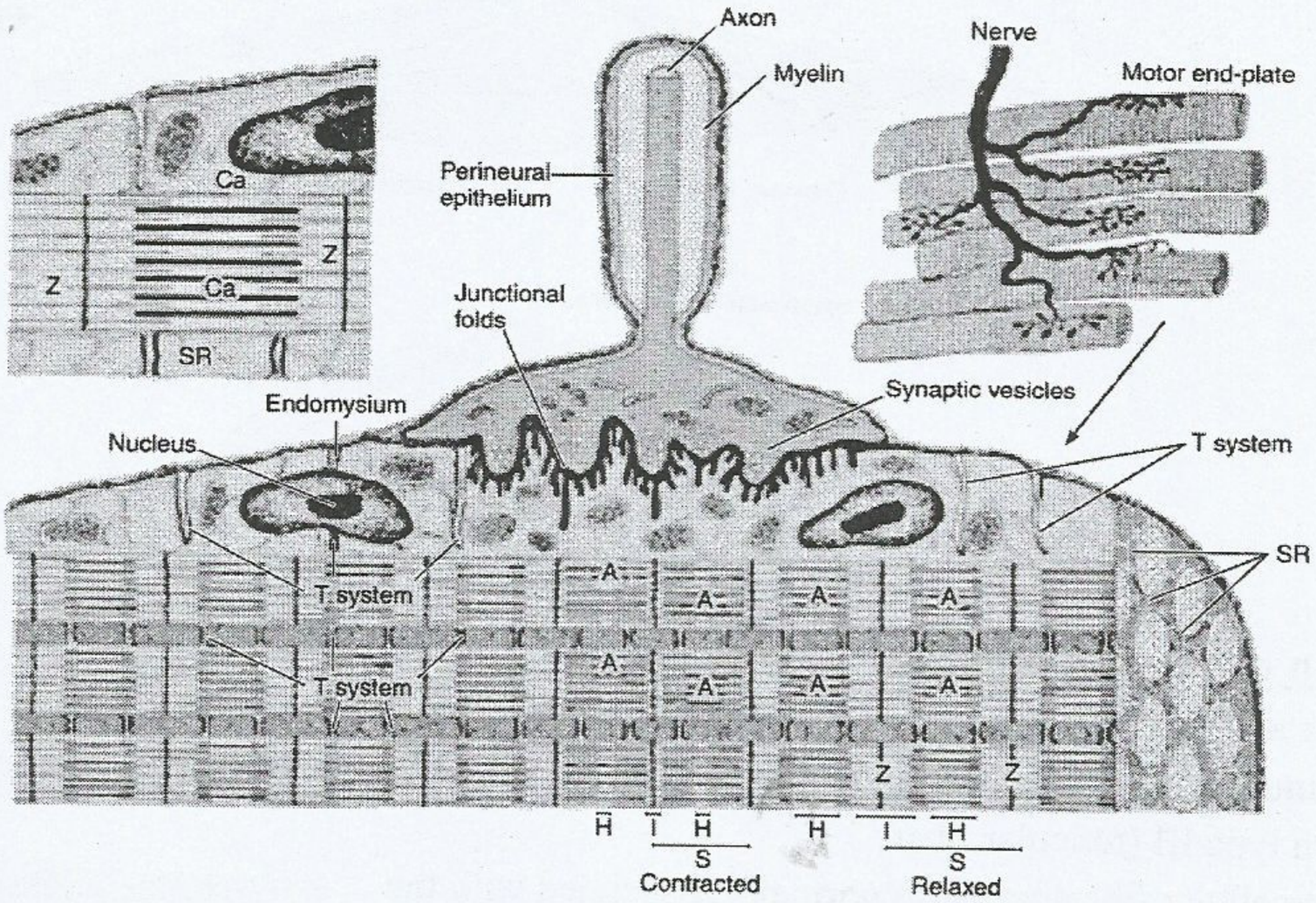
♦Muscle contraction begins with the release of acetylcholine from the synaptic vesicles of the end-plate.

♦ This neurotransmitter causes a local increase in the permeability of the sarcolemma.

♦ The process is propagated to the rest of the sarcolemma, including its invaginations (the T system), and is transferred to the sarcoplasmic reticulum (SR).

♦ The increase of permeability in this organelle liberates calcium ions that trigger the sliding filament mechanism of muscle contraction.

♦ Thin filaments slide between the thick filaments and reduce the distance between the Z lines, thereby reducing the size of all bands except the A band

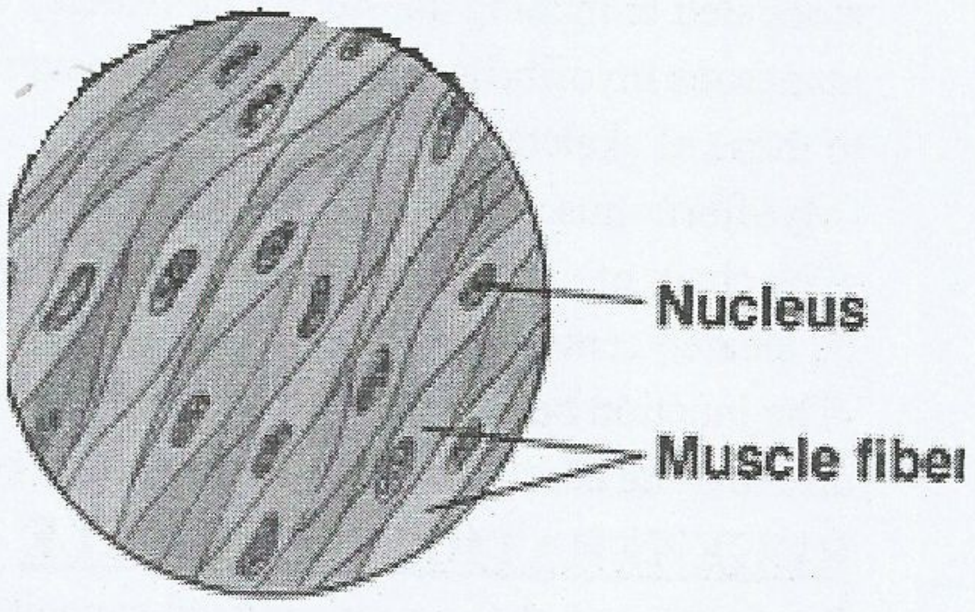


Smooth muscle (non-striated, Involuntary)

-Each cell has single nucleus located in center of broadest part of the cell.

-Each of which is enclosed by basal lamina and net work of reticular fibers

-At the poles of cell are mitochondria, free ribosomes, rough endoplasmic reticulum and Golgi complex and smooth endoplasmic reticulum



SMOOTH MUSCLE

The contractile activity of smooth muscle.

-Is related to the organization of its actin and myosin filament, which is different at organization present in striated muscle.

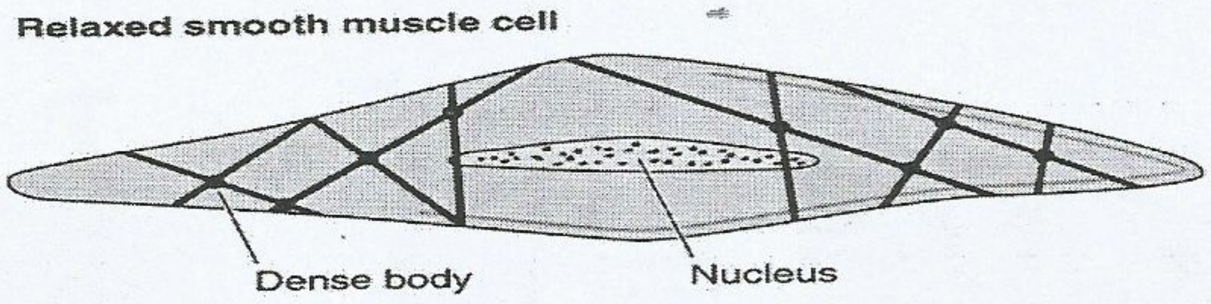
-In smooth muscle fibers, bundles of myofilaments crisscross obliquely through the cell, forming like network.

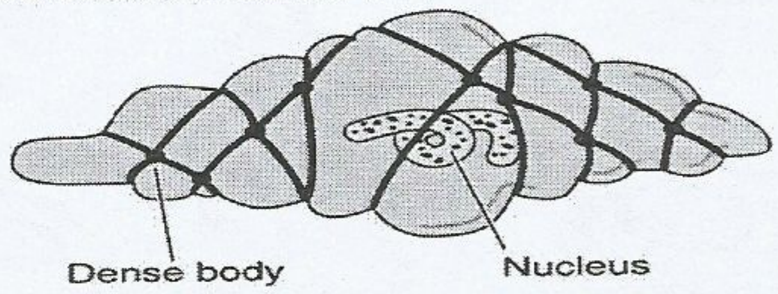
-These bundles consist of thin filaments containing actinand thick filaments of myosin and intermediate filaments

*S*mall dark staining patches are in sarcolemma and sarcoplasm are termeddense bodies, contain actin (similar to the *Z* line of striated muscle).

-The both thin and intermediate filament insert into dense bodies that transmit contractile force to muscle cell.

-" T " tubules are not present in smooth muscle.





Function of smooth muscle:

-The contractile activity.

-Smooth muscle cells have been shown to synthesize collagen and elastin, the collagen was produced is collagen type III (reticular fiber)

-And extracellular fibers products normally associated with the function of fibroblast.

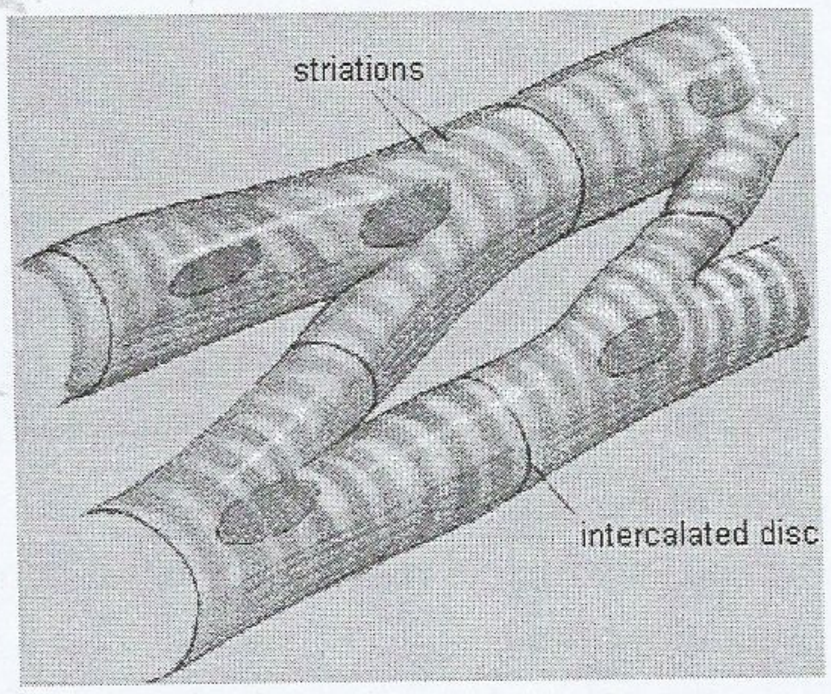
Cardiac muscle

Structure of cardiac muscle:-Cardiac muscle made up by elongated branching anastomizing (fibers) which are has numerous myofibrils that show the transverse striations similar to those of skeletal muscle A,I,Z,H

-Myofibril muscle made up by actins and myosin

-The chain of cardiac muscle cells each having its own nucleus its located centrally

-The junction between the adjacent myocytes are intercalated disc and the cardiac muscle are in voluntary.



REGENERATION OF MUSCLE TISSUE:

- Cardiac muscle has no regenerated capacity
- Defects or damage in heart muscle is replaced by connective tissue, forming myocardial scars.
- Skeletal muscle cells they are incapable undergoing the mitosis, it is believed the tissue undergoes regeneration from inactivemyoblasts that when become activated they form new skeletal muscle fibers.
- Smooth muscle is capable of a modest regenerative response.

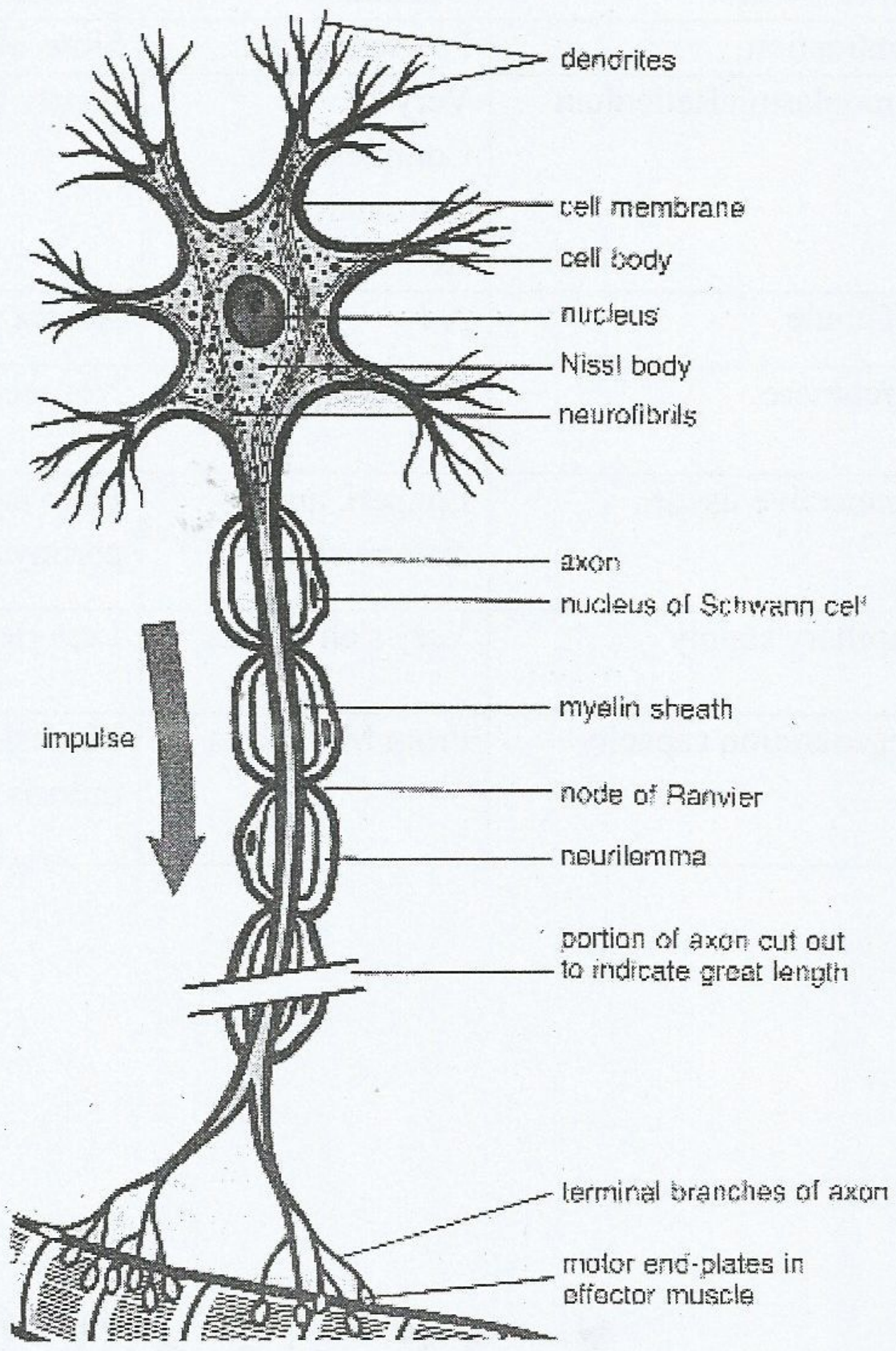
SUMMARY OF MUSCLE TYPE CHARACTERISTICS

characteristics	Skeletal	smooth	Cardiac
Location	Attached ToSkeleton	HollowViscera, Blood vessels walls	Myocardium
CellsShape	Large ParallelFiber	Fusiform	Pseudosyncytium,elongated
TransverseStriation	Present	Absent	Present
Nucleus	Multinucleated Peripheral	Single ، CentrallyLocated	Single, centrallyLocated
Nerve Control	Voluntary	Involuntary	Voluntary
Contraction	Powerful, Fast	Slow ،Rhythmic	Powerful ،Constant
SarcoplasmicReticulum	Very ComplexWith TerminalCisternae At	Poorly Developed	Less Developed At IntercalatedDiscs ،no Cisternae
T Tubule	A-I	Absent	Intercalated Disc
Sarcomere	Well seen	Not seen	Less well seen
Connective tissue	Epi,peri, and endomysium	Endo and some perimysium	Endomysium
Capillary supply	Very rich plexus	Less rich	Extremely rich
Regeneration capacity	From Myoblasts	Modest response by mitosis	Not capacity at all, replaced by connective tissue

NERVOUS TISSUE

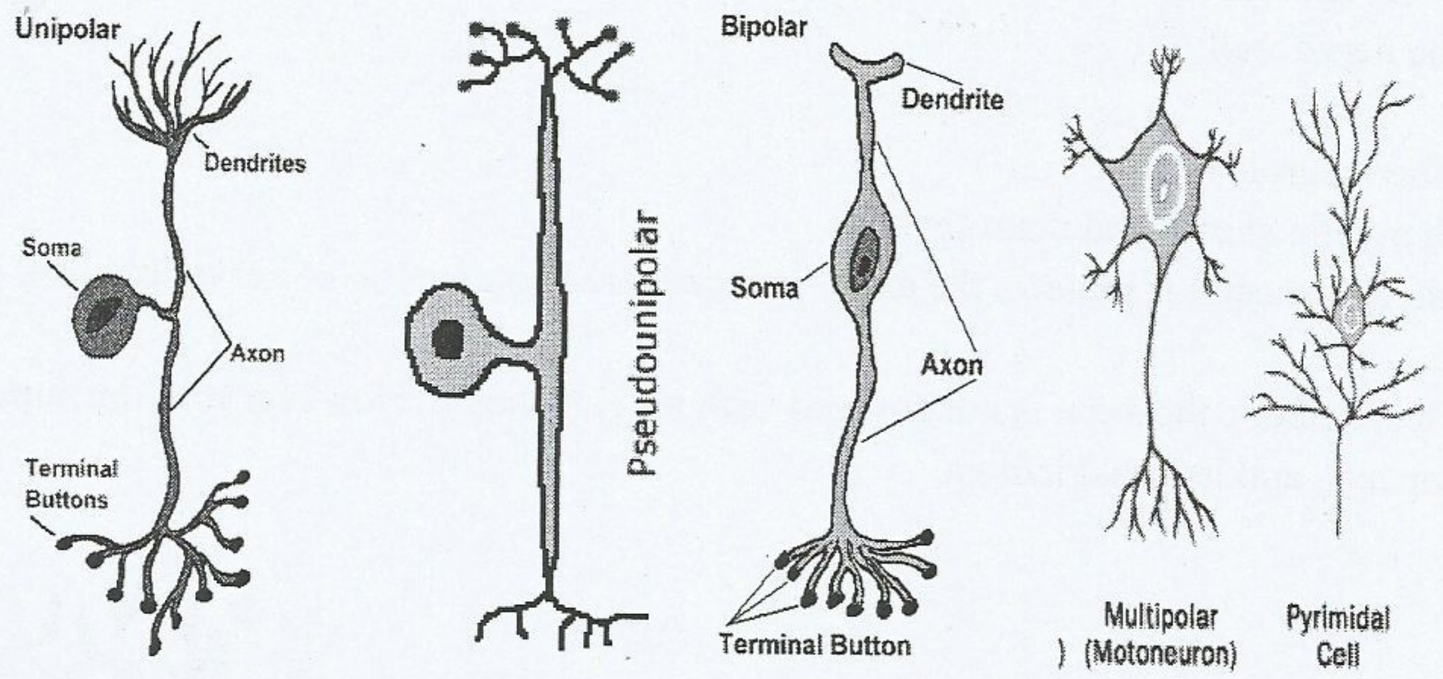
Consists of two groups of cell types:
1- Nerve cells (Neurons)
2- Neuroglia
NEURON: The neuron is the morpho-functional unit of the nervous system
Neurons have two special properties :
- Irritability :the ability to respond to a stimulus
- propagation of impulses: the ability to conduct impulses

Nerve cells (Neurons):
1) Cell Body - contains nucleus or perikaryon, it is the trophic center of the neuron involved in protein synthesis
2) Cell Processes
a) Dendrites = stimulus receiving and impulse-generating component, carries impulse to cell body
b) Axon = propagates impulse, carries impulse away from cell body
1- Cell Body or SOMA usually large, nucleus lies near center of cell body and is pale-staining but has single dark-staining nucleolus within cytoplasm of cell body and proximal cell processes are Nissl Bodies = ribosome-rich regions active in protein synthesis; many mitochondria are also present. Golgi bodies and Neurofibrils.
2- Axon usually longest process of neuron ,joins cell body at AxonHillock = pale-staining region; contains mitochondria but no ribosomes or Golgi or RER, It is the point of origin of the axon from the perikaryon.
The plasma membrane of the axon is termed the axolemma, and the cytoplasm of the axon is termed the axoplasm. The axon branches at its end (Terminal branches). The axon forms small, bulb-shaped swellings (terminal buttons)



3-Dendrites are generally shorter and highly branched, multiple most often; largerregions with same subcellular components as cell body

Morphological classification of neurons :
1- Unipolar = cell body + axon only (photoreceptors of eye, embryonically)
2- Pseudounipolar = proximal regions of axon and dendrite fuse to form single common segment leaving cell body (spinal ganglia
3-Bipolar = single axon + single dendrite (retina of eye)
4-Multipolar = numerous dendrites + one axon (by far the most common)



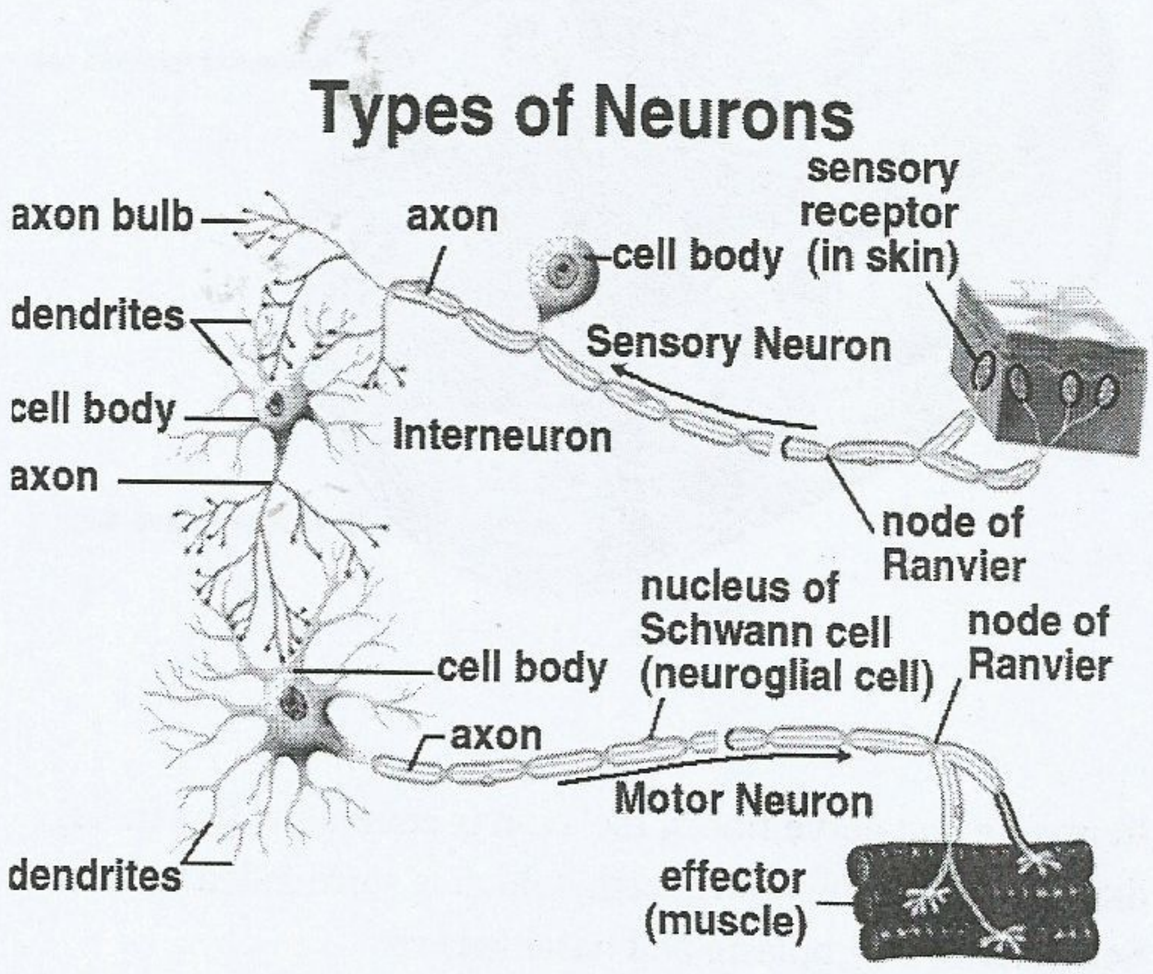
Physiological classification of neurons :

■ Sensory neurons. These receive sensory stimuli from the environment (from receptors) and from within the body (e.g. Unipolar neurons).

■ Motor neurons. These control the effectors organs (muscles, exocrine glands, endocrine glands) .

■ Interneuron (Intermediate neurons). These are typically found in the CNS and connect between other neurons (often between sensory and motor neurons).

■ Neurosecretory neurons. These are specialized neurons that synthesize and secrete hormones.

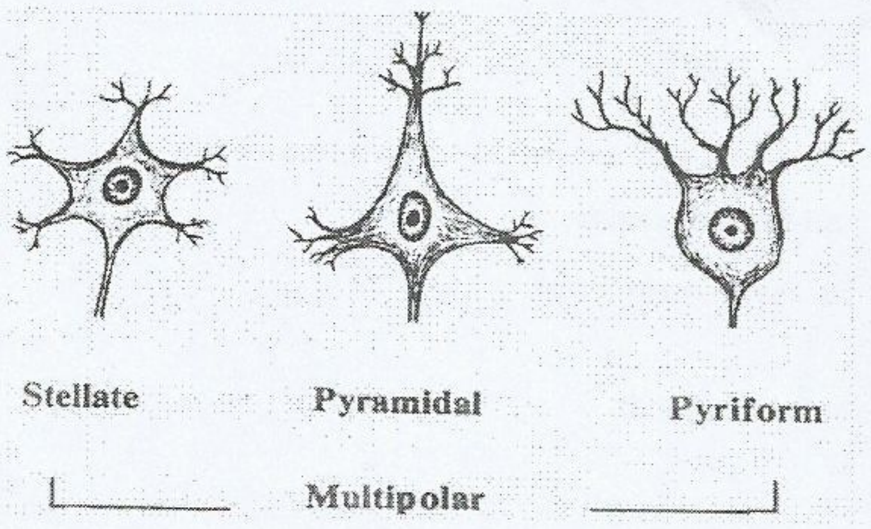


classified according to their shape bodies into 3 kinds

a) Polygonal cells (satellite neurons), e.g. the cells of the anterior horn, and the sympathetic ganglia.

b) Pyramidal cells resemble a pyramidal, with a long a apical dendrite arising from its apex, and an axon arising from its base. e.g. the cells of the cerebral cortex

c) pyriform cells, are large, and flask-shaped, with an extensively branching apical dendrite. E.g. purkinje cells of the cerebellum



PERIPHERAL NERVE FIBERS

It Is the axon of the nerve cell.

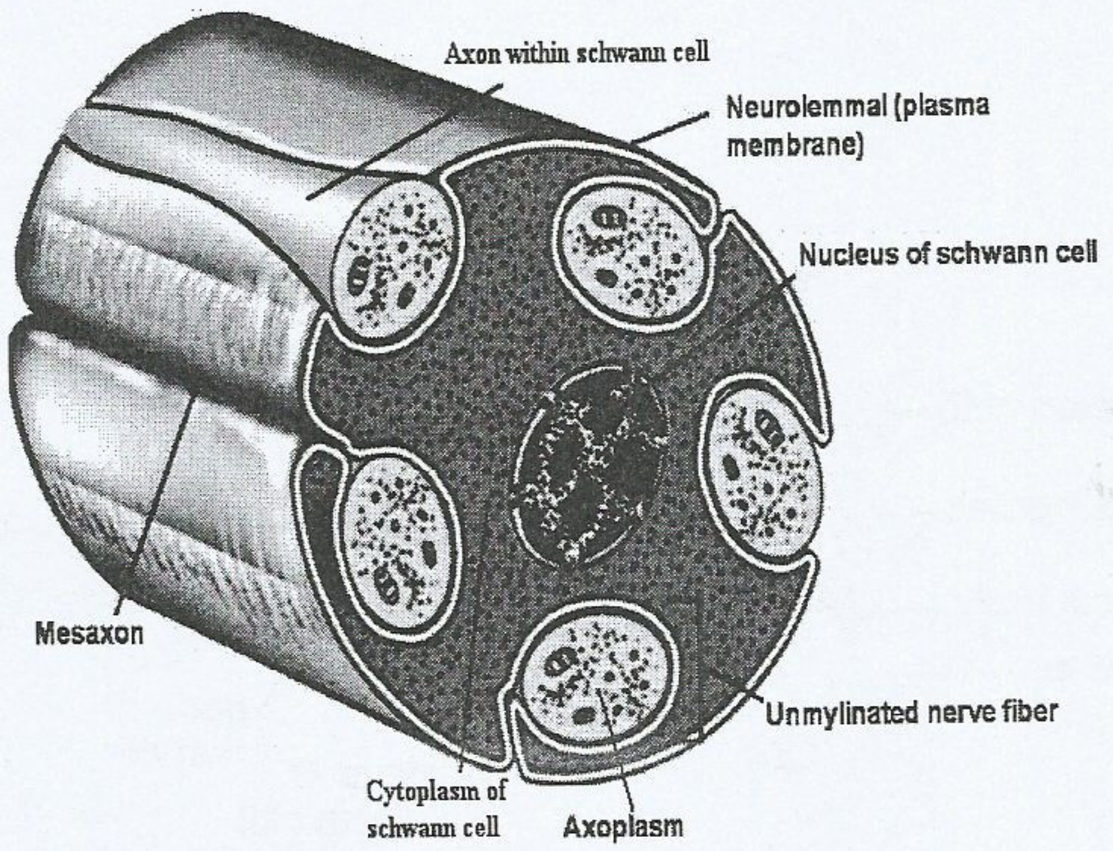
It may be

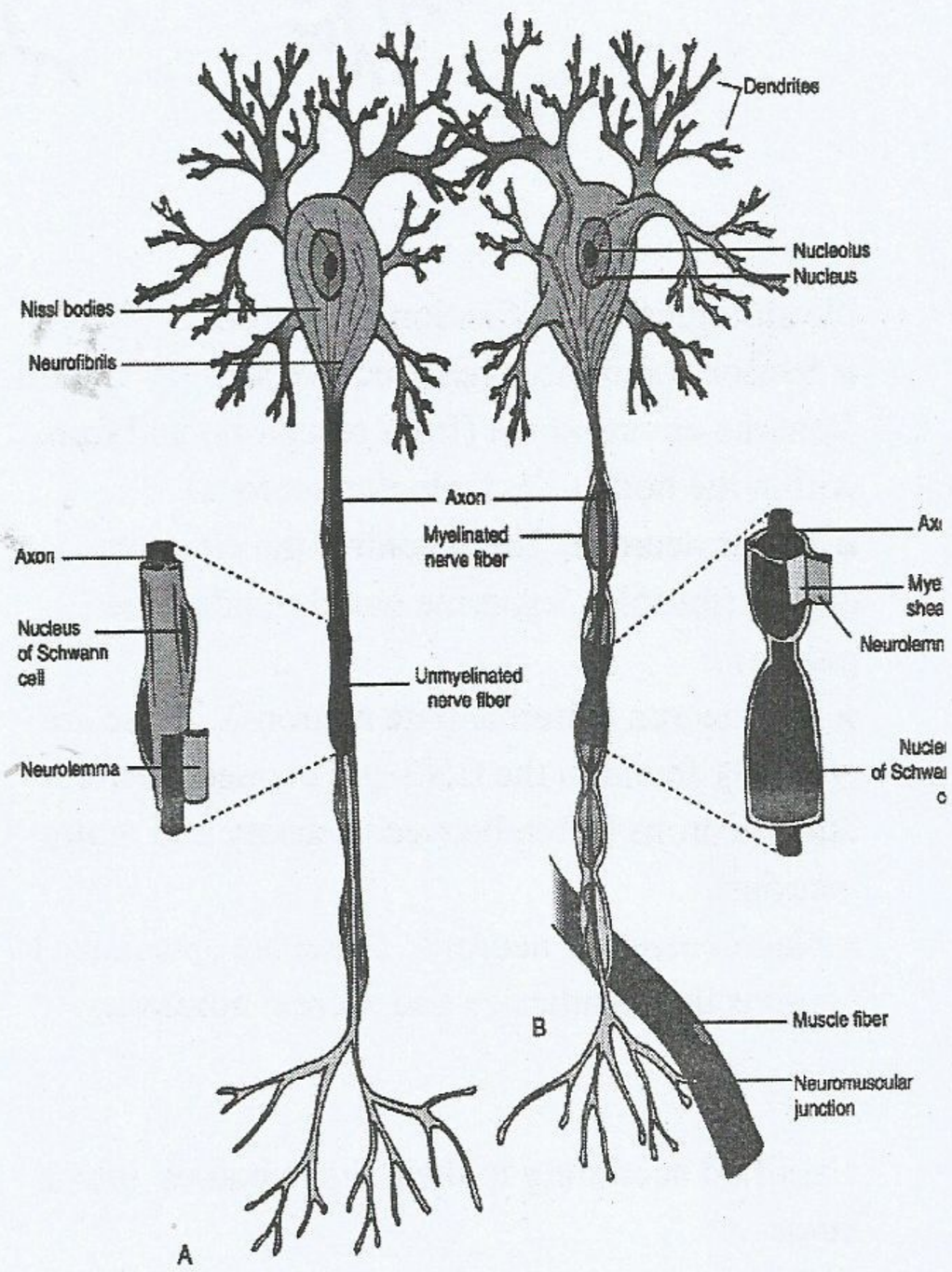
1-nonmylinated fiber neurolemma

2-ensheated (with myelin sheath and neurolemma .

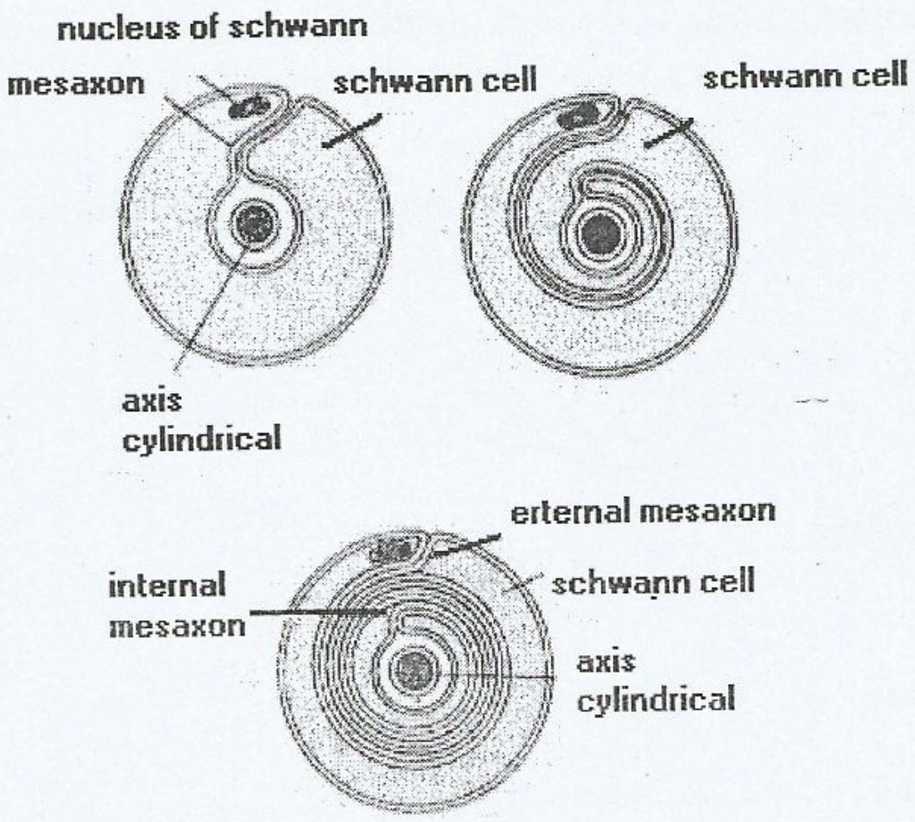
Functions of the myelin sheath: it protects the axon. It accelerated conduction of nerve impulse. It also isolates nerve impulses

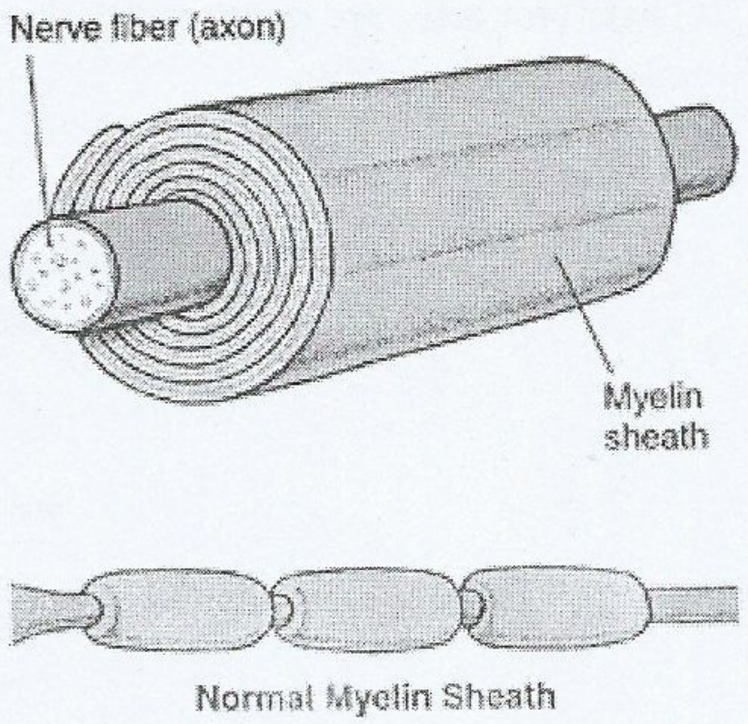
In unmyelinated nerve fibers, the axon is not covered with myelin sheath. However it is surrounded by Schwann cell cytoplasm and its basal lamina.





In myelinated nerve fibers, the axon is covered with parallel dark lamellae of myelin sheath, which is surrounded by thin Schwann cell cytoplasm and basal lamina



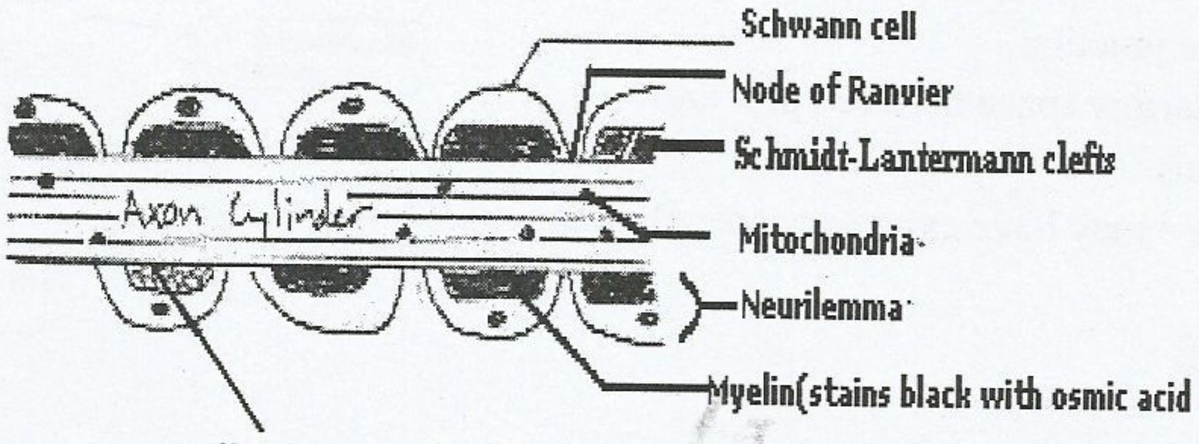


NERVE

Normal Myelin Sheath

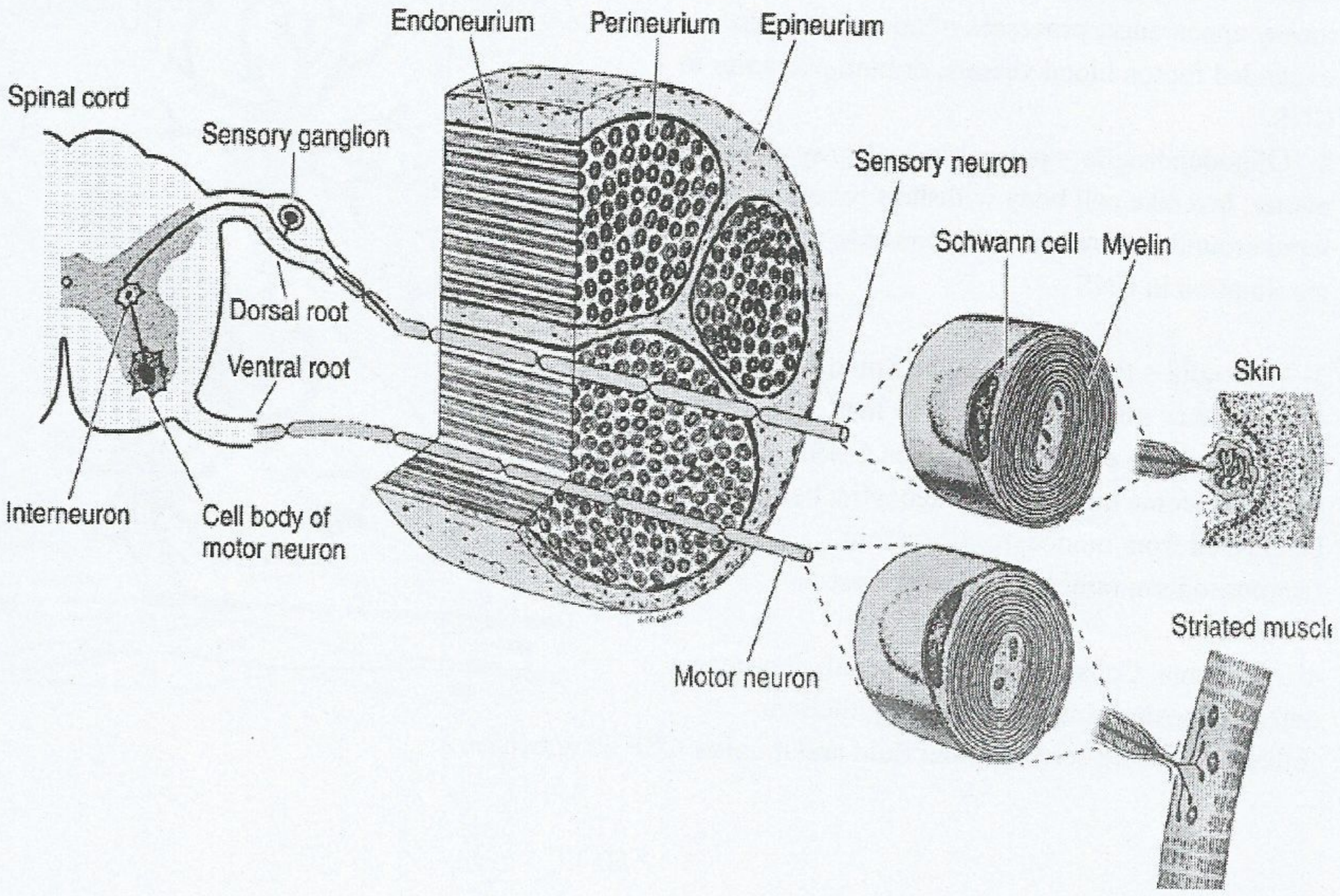
FIBERS (AXONAL TRANSPORT)

The Myelin Sheath is produced by oligodendrocytes in CNS and by Schwann cells in the PNS.
It consist of several spiral layers of plasma membrane of oligodendrocytes or Schwann cells
Myelin Sheath is interrupted at regular intervals = Node of Ranvier - these act to increase velocity of conduction by allowing nerve impulse to jump from node-to-node
(saltatory conduction) rather than proceed slowly down the plasma membrane as in the unmyelinated neuron.Internodes are segment of nerve fibers between adjacent nodes of ranvier



Myelin dissolved in H&E,leave neurokeratin framworks

Connective tissue investments



SYNAPSE:

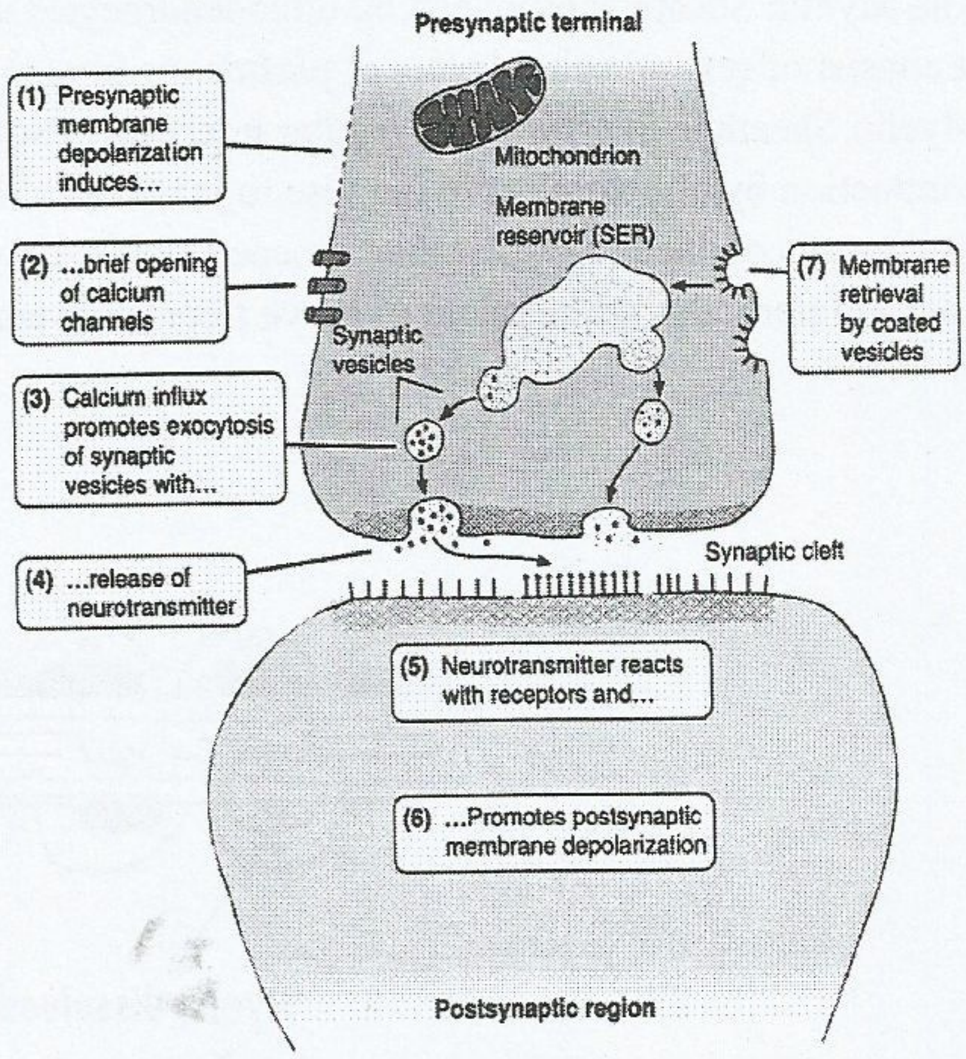
it sites where nerve impulse passes from one neuron to another it involves through chemical mediator = neurotransmitter.

1-Presynaptic Terminal = portion which delivers impulse, usually is a terminalexpansion of axon

2-Postsynaptic Terminal = portion which receives impulse, usually a dendrite or lesscommonly a cell body and very rarely another axon; also can be an effectors cell membrane (as in a nerve-muscle junction

3-Synaptic Cleft = narrow space between pre- and postsynaptic terminals

٤-Neurotransmitters = may have excitatory (depolarizing) or inhibitory



Types of SYNAPSE

1-Axo- dendritic.

2- Axo- somatic.

3- Axo- axonic between axon and another axon.

4-Dendro-dendritic neurones

5- Synaptic contact also between neurons and muscle and gland cells

NEUROGLIA CELLS = modified nerve cells, arise embryonically from neural cresttissue

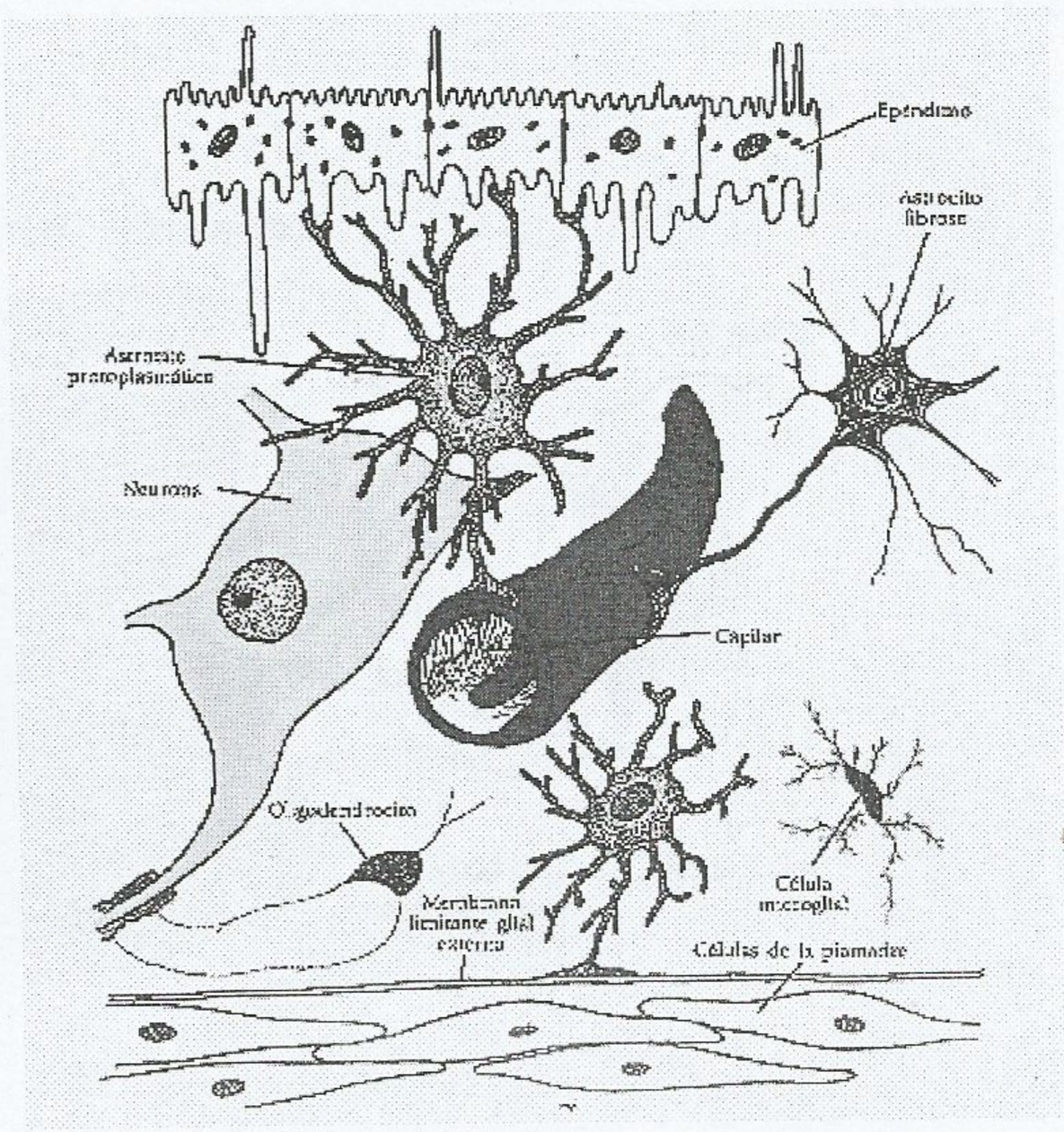
Astrocyte - 2 Types:

a) Fibrous = occurs in white matter of brain, have smaller number of cell processes, so take on star- like appearance, processes are generally straight; some areattached to blood vessels

b) Protoplasmic = occur in gray matter, have large number of highly branched processes so take on mossy appearance; processes often terminate in expanded footon blood vessels, or bind pia mater to CNS.

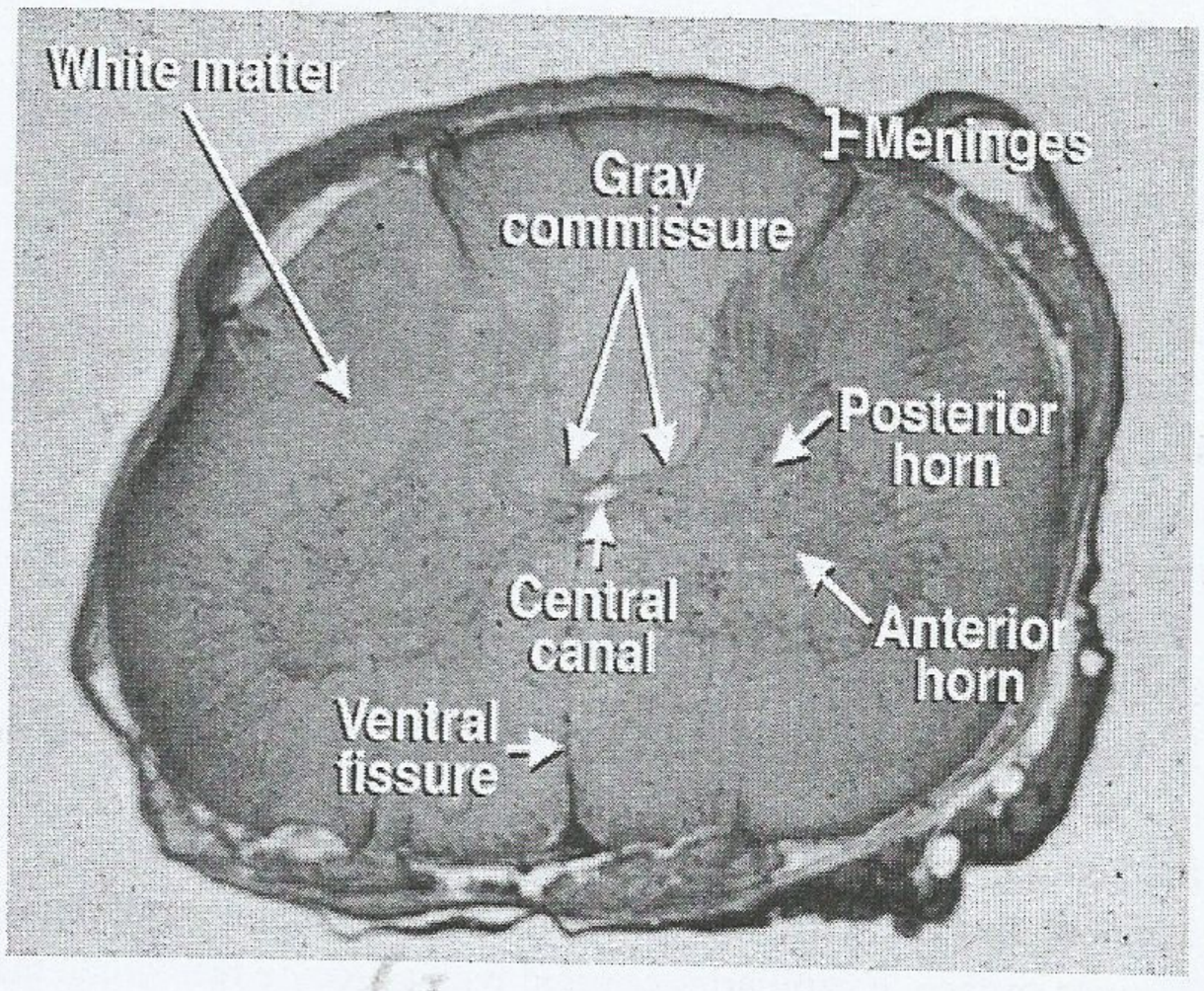
2- Oligodendroglia = present in both gray and white matter; box-like cell body withshort processes that wrap around nearby axons, responsible for myelination in CNS

3- Microglia = tiny cells; may be Spindle-shaped, oval nucleus; mainly foundin gray matter near blood vessels and nerve cell bodies; upon CNS damagebecome motile and phagocytic; believed to be derived from monocytes (therefore frommesoderm rather than neural crest

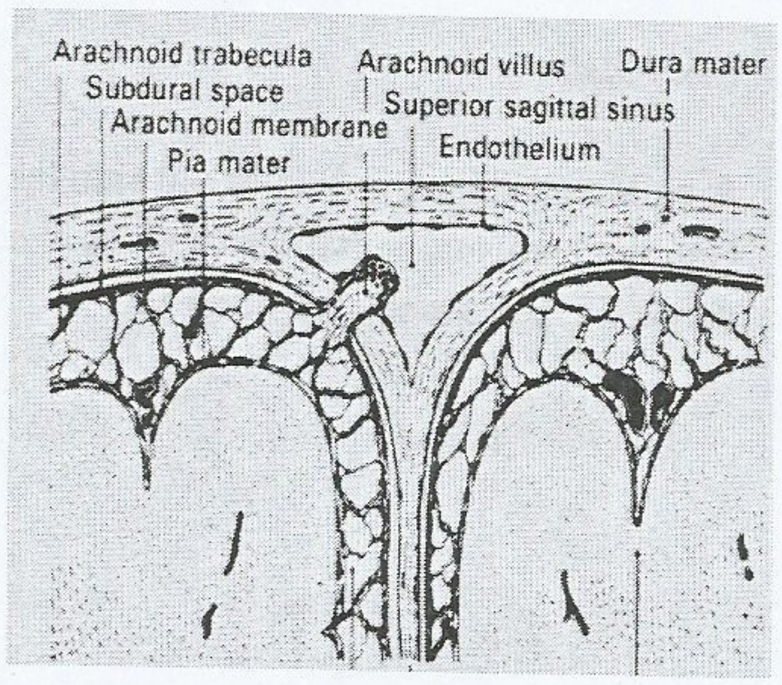


4-Ependymal Cells = line central canal; non-neural cells composing simple cuboidal epithelium (ciliated); secrete cerebrospinal fluid and monitor CSF composition

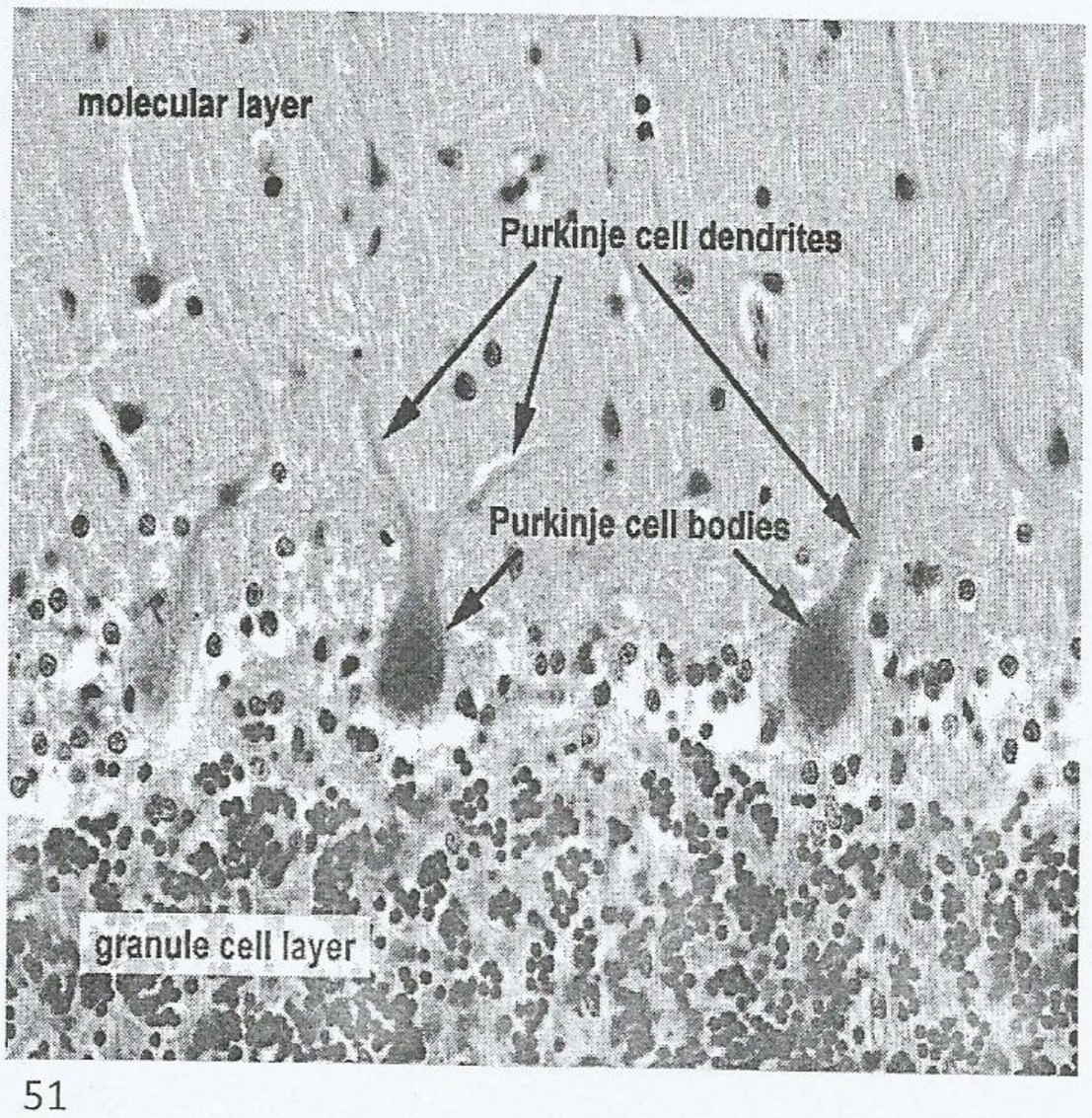
spinal cord: In cross-section of the white matter is peripheral and gray matter is central having the shape of H.
The center of the horizontal bar of this H is the central canal lined by ependymal cell.
The vertical lines of the H form the anterior and posterior horn. Spinal cord neurons are large and multipolar especially in the anterior horns.
White matter formed by nerve fibers surrounds the gray matter and is divided into:- longitudinal columns, formed by myelinated and some unmyelinated fibers



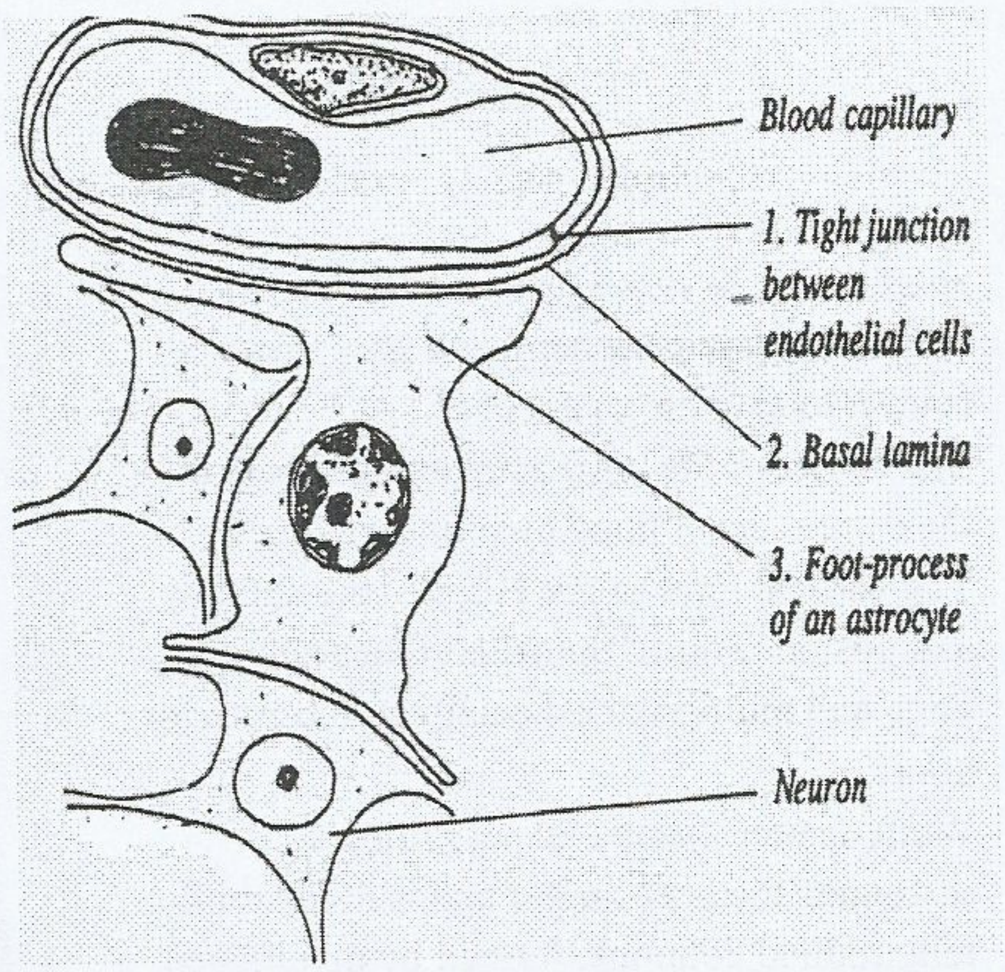
Meninges =Connective tissue membranes covering CNS
1- .Pia Mater = innermost, vascular loose CT, adheres to surface of CNS, lined bysimple squamous epithelium on outside
2- .Arachnoid = thin, delicate non-vascular membrane with trabeculae extending
inwardly, contains collagen and elastic fibers; covered on outside by simple
squamous epithelium
3- Dura Mater = outermost, dense CT protective covering of collagen fibers + someelastic fibers
Subarachnoid Spaceseparates pia and arachnoid, filled with CSF
Subdural Spaceseparates arachnoid from dura, filled with lymph-like fluid



CEREBRUM: responsible for consciousness, intelligence, thought, interpretation of sensations
Gray Matter organized into six somewhat indistinct layers of nerve cell bodies. Lies on outside in brain.
1) Molecular Layer
2) outer Granular Layer
3)outer Pyramidal Cell Layer = neurons with pyramid-shaped cell body.
4) Inner Granular Layer = relatively small association neurons, myelinated fibers
5) Inner Pyramidal Cell Layer = contains pyramidal cells and small neurons
6) Polymorphic Cell Layer = polymorphous neurons - small neurons with spindle-shaped cell body and branching dendrites;
CEREBELLUM = coordination of motor movements
Composed of superficial cortex of gray matter covering a deeper body of white matter-Cortex folded into many transverse ridges



1) Molecular Layer = outermost; contains glial cells, dendrites and many unmyelinated axons; also contains stellate cells and basket cells.
2) Purkinje Layer = middle layer composed of a single layer of large flask-shaped purkinje neurons with a few major branched dendrites extending into molecular layer.
3) Granular Layer = innermost; contains cell bodies of small neurons, granule cells (multipolar neurons with small dark round nucleus, little cytoplasm and no Nissl bodies; relay impulses from body to Purkinje cells) and Golgi cells.



BLOOD-BRAIN BARRIER

Components:

1- Capillaries within brain lined by endothelium , each cell bounded by tight junctions which restricts passage of dissolved molecules fromcapillary to brain tissue.

Pinocytosis transfer of fluid across endothelium is restricted

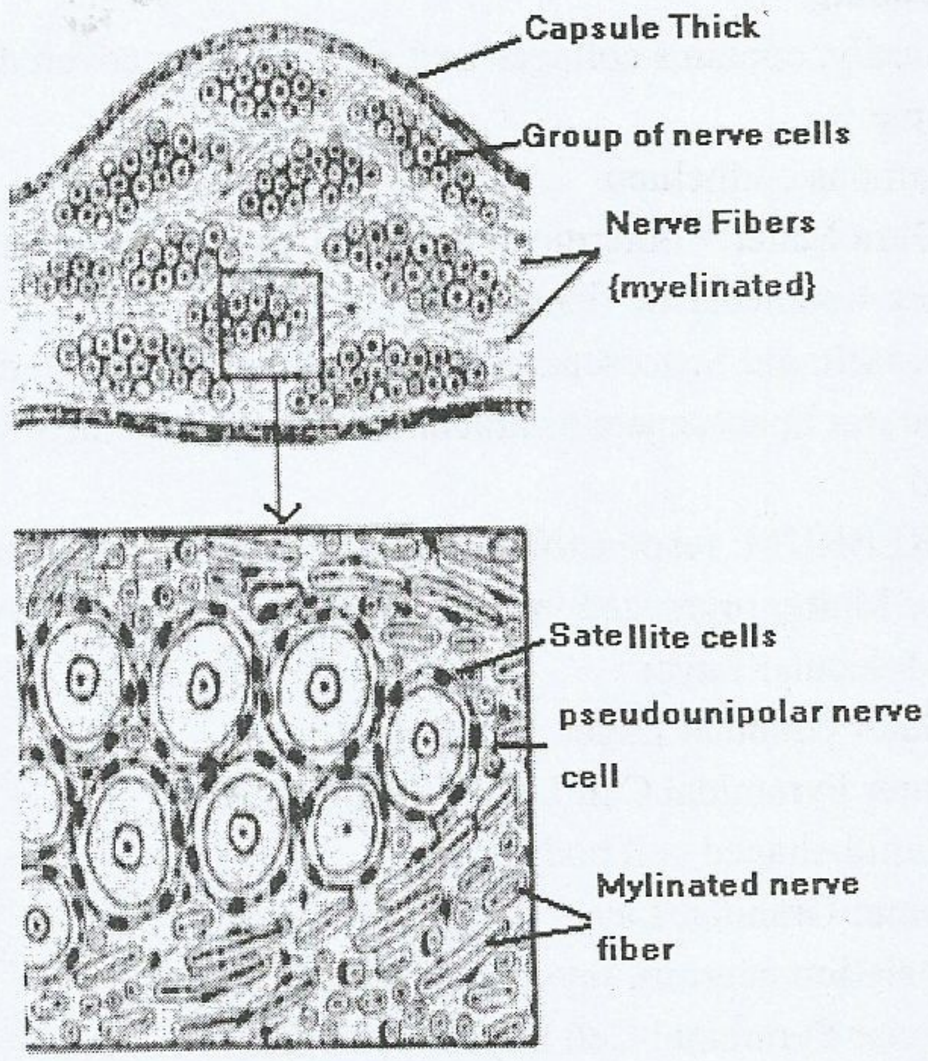
2- Capillaries also surrounded by extra thick basement membrane

3- outer surface of capillaries covered with astrocyte feet which may further regulatepassage of molecules

GANGLIA

A collection of nerve bodies out side the CNS

Ganglia are usually ovoid structures encapsulated by dense CT and associated nerves



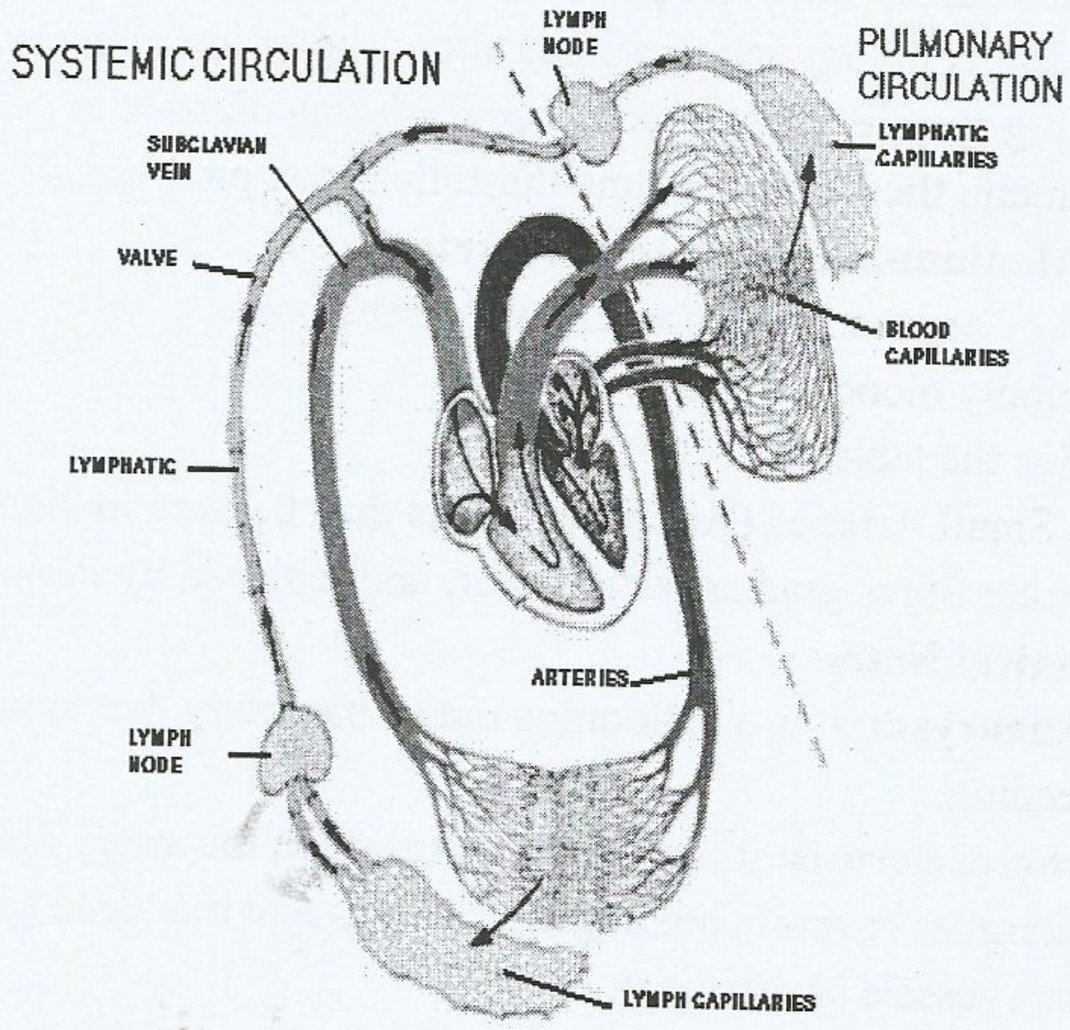
Spinal Gangloia at LM

THE CARDIOVASCULAR SYSTEM

WALL OF THE HEART

Consists of the following layers:

1. Endocardium: consists of endothelium and subendothelial C.T. layer. Underneath, the subendocardium is made of loose C.T. with vessels, nerves and Purkinjé fibres.
2. Myocardium: formed of cardiac muscle fibres, arranged in different directions (see cardiac muscle fibres).
3. Pericardium: consists of loose C.T. (contains fat cells and the coronary blood vessels), covered by mesothelium (simple squamous epithelium).



BLOOD VESSELS

General Histological Structure (from inside to outside):

1. Tunica Intima (interna): formed of:

a) Endothelium: simple squamous epithelium.

b) Subendothelium: loose C.T.

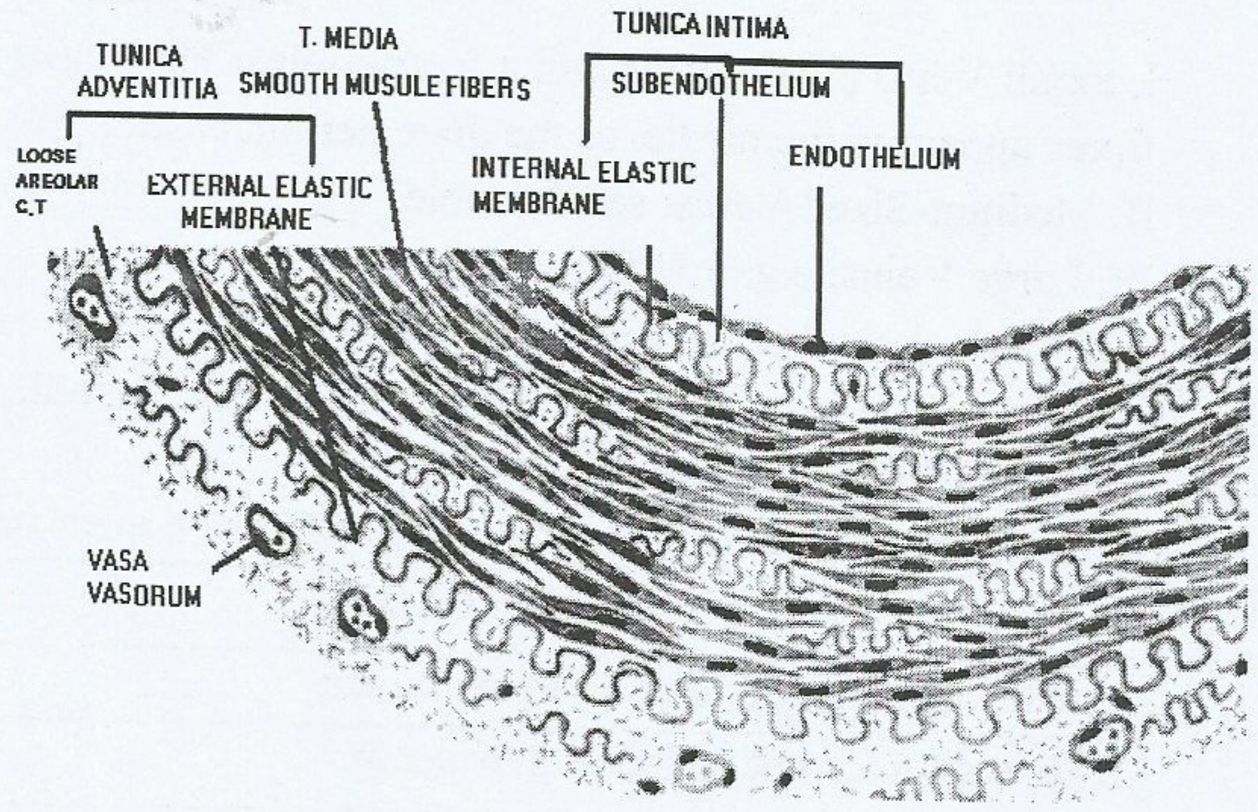
C) Internal elastic lamina (IEL): made of elastic fibres.

2. Tunica Media: consists of circularly arranged smooth muscle and elastic fibres.
3. Tunica Adventitia (Externa): consists of:

a) External elastic lamina (EEL).

a- external elastic lamina

b-loose layer



Arteries

Arteries are classified according to size into:

- Large elastic (conducting) arteries.
- Medium-sized muscular (distributing) arteries: deliver blood to organs.
- Small arteries (arterioles): regulate the blood flow into the capillary bed.

I. Large Elastic Arteries: e.g. aorta, pulmonary and subclavian arteries. They Have a thick wall and a wide lumen. The wall of the aorta (e.g.) is formed of:

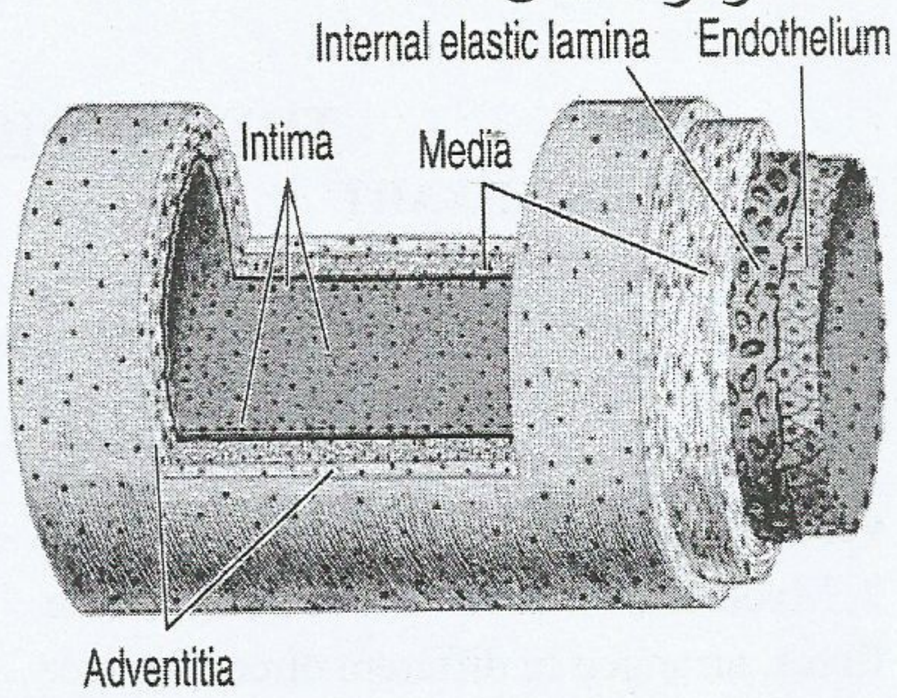
1. Tunica Intima: consists of:

a) Endothelium: simple squamous epithelium. Endothelial cells are joined by gap junctions.

b) Subendothelium: loose C.T., contains fibroblasts, collagen and elastic fibres.

c) Non-clear internal elastic lamina.

2. Tunica Media: thick layer made of 40-70 laminae of fenestrated elastic membranes. Smooth muscle fibres and collagen fibres are found between the elastic laminae.



3. Tunica Adventitia: is narrow and consists of loose C.T., containing **vasa vasorum.** They are small blood vessels which supply the outer part of the aortic wall.

Histophysiology: elastic fibres allow expansion of aorta during systole. Elastic recoil occurs during diastole to maintain the blood flow and diastolic blood pressure.

1. Medium-Sized (Muscular) Arteries:

- They are the most common type in the body.
- Supply blood to organs.
- See the table.

Ill. Small Arteries (Arterioles): Less than 0.1 mm in diameter. IEL gradually disappears. Smooth muscle fibres gradually disappear, and replaced by Pericytes. Adventitia is very thin.

Clinical Notes:

- **Aneurysm**: it is a ballooning out of the artery due to weakness in the wall. It may burst causing bleeding.

Atherosclerosis: it is a condition in which the artery loses its elasticity. The wall of the artery undergoes several pathological changes that may lead to its complete occlusion. Its occurrence in heart vessels causes heart attack.

Veins

I. Small Veins (Venules): Similar to arterioles. They have a diameter of 0.2-1 mm.. Smooth muscle fibres appear in the media, as the diameter increases.

II. Medium-Sized Veins: see the table.

Ill. Large Veins: e.g. inferior vena cava:

- has a thick wall and a wide lumen.
- has a thin media and a thick adventitia (contains bundles of longitudinal smooth muscle fibres).
- has no elastic Laminae.

Differences between a medium-sized artery and a medium-sized vein.

Medium-Sized Artery	Medium-Size Vein
1. It has a thick wall and a narrow lumen	1. It has a thin wall and a wide lumen
2. Its wall does not collapse after death	2. Its wall collapses after death
3. The lumen contains no blood after death	3. The lumen contains blood after death
4. It has no valves	4. It has valves
5. The tunica intima is thick and its is poor in elastic fibres	5. The intima is thin and its Subendothelium is rich in elastic fibres
6. It has a clear internal elastic lamina	6. There is no internal elastic lamina
7. The tunica media is thick and made of smooth muscle fibres and scattered elastic fibres	7. The media is thin & poor in elastic fibres
8. The external elastic lamina may be present or absent 9. The tunica adventitia is narrow and rich in elastic fibres	9- The tunica adventitia is wide and rich in collagenous fibres

CONNECTION BETWEEN ARTERIES AND VEINS

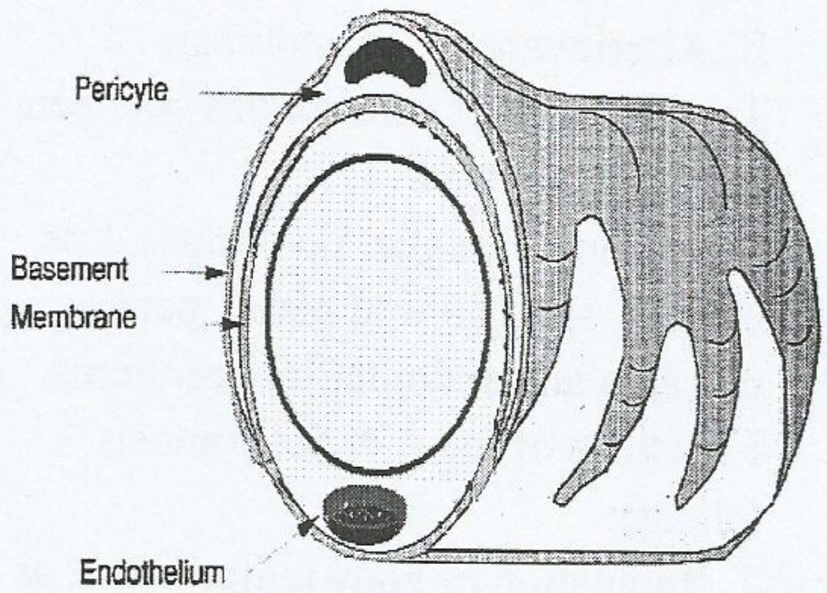
I. Blood Capillaries

Size: Most capillaries have a diameter ranging from 7-9 .tm and their length varies between 0.25-1 mm.

Structure:

▶ Capillaries are formed of endothelium, resting on a basal lamina (produced by the endothelial cells).

▶Endothelium is formed of simple squamous epithelium. Cytoplasm of the endothelial cells contains abundant microtubules and intermediate filaments which contribute the contractility of capillaries. Endothelial cells are connected together by tight and gap junctions.



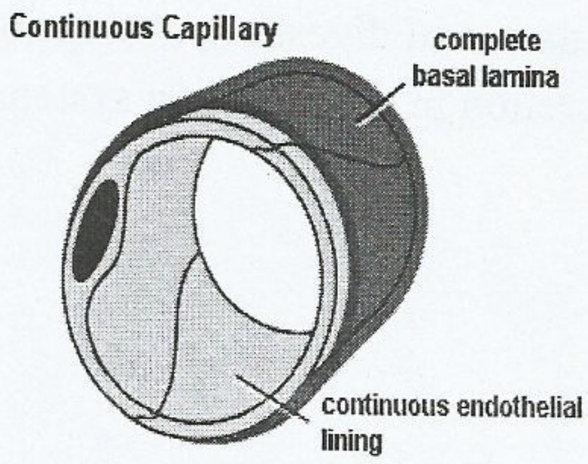
▶Pericytes: are found around the endothelium. They contain actin, myosin an tropomyosin, giving them a contractile ability. So, they could be considered as media of the capillaries. They also have the power to change to endothelial and C.T. cells, in response to injury.

Types of Capillaries:

1. Continuous (Somatic) Capillaries (most common):

• Sites: They are found in connective tissue, skeletal muscles, brain, bones, lungs and exocrine glands.

Histological structure: endothelium forms a continuous layer, resting on a thin continuous basement membrane.

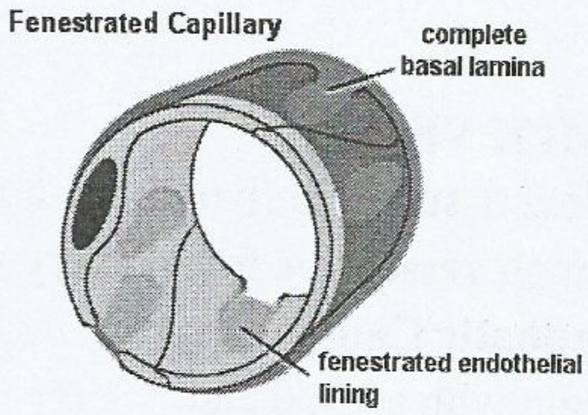


2. Fenestrated (Visceral) Capillaries:

• Sites: They are found in:

(a) Endocrine glands (to transport hormones to blood).

(b) Renal glomerulus (for blood filtration).



• Histological structure: Endothelial cells contain pores (fenestrae) and they rest on a thin continuous basement membrane. Mostly the fenestrae are covered by a diaphragm. However, the fenestrae of the renal capillaries do not have Diaphragms.

3. Discontinuous Sinusoidal Capillaries (Blood Sinusoids):

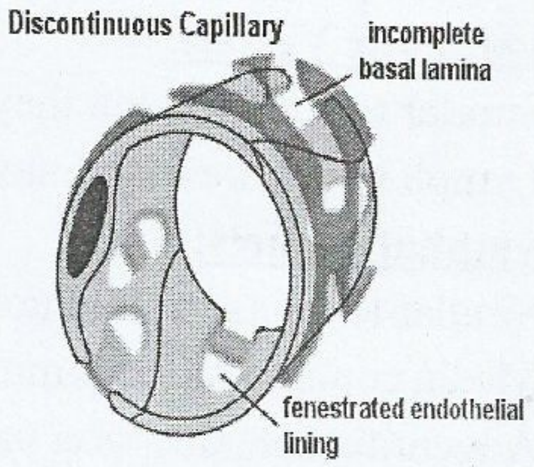
• Sites: They are found in:

(a) Liver: to allow easy passage of the proteins, secreted by the hepatocytes, into the blood stream.

(b) Spleen (red pulp): to allow the passage of stored blood into the circulation.

(c) Bone marrow: to allow the passage of the formed blood elements into the circulation.

(d) Endocrine glands: to carry the formed hormones into blood stream.



Histological structure:

1- They have a large diameter (up to 40 μm) and irregular wall.

2- Endothelial cells are separated by large intercellular gaps (pores).

3- Basement membrane is either discontinuous or non-existent.

4- They are surrounded by macrophages, with their pseudopodia extending through the pores into the lumen (called littoral cells).

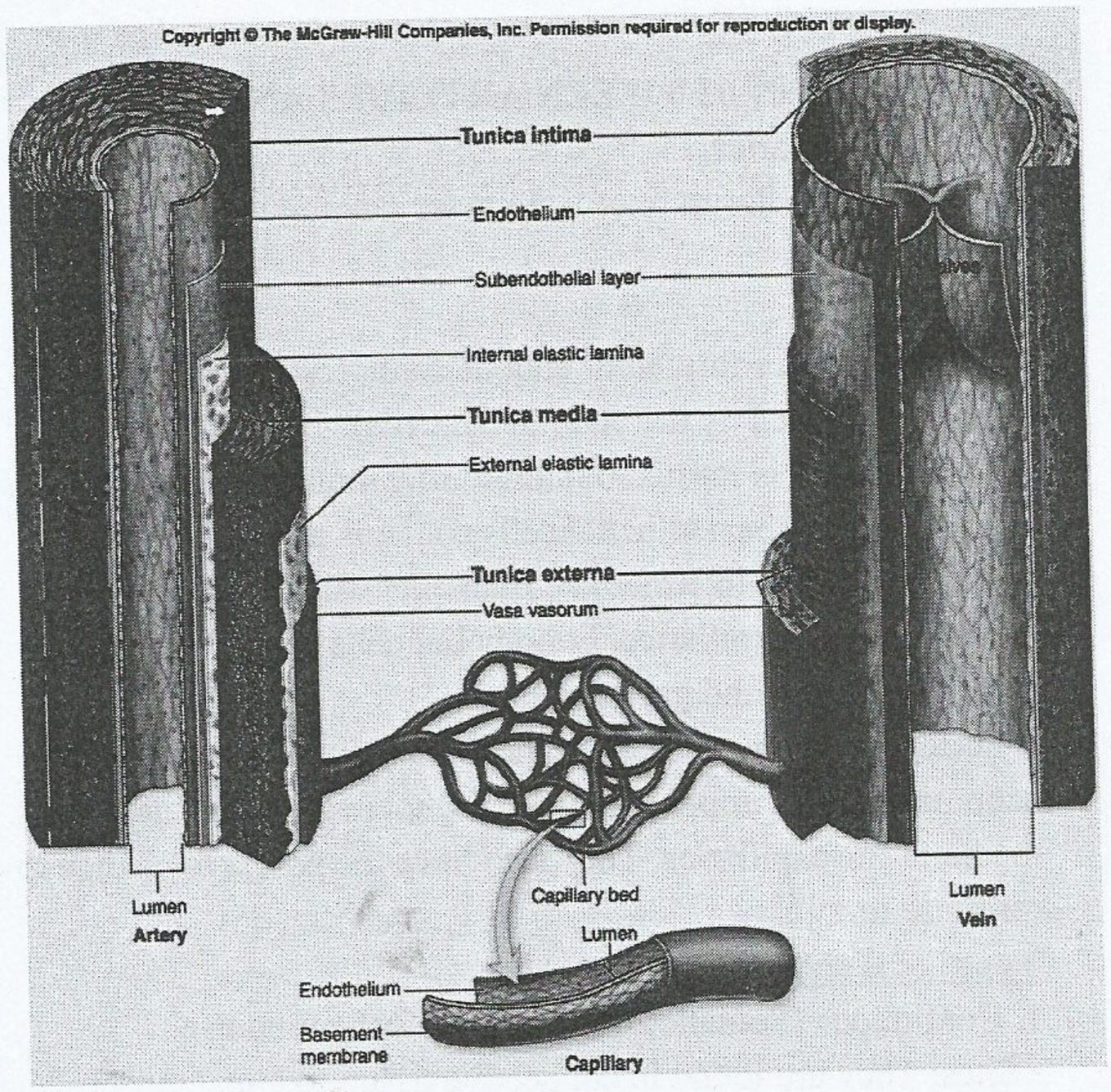
II. Arteriovenous Anastomosis

These are direct connections between arteries and veins.

Sites: Tip of tongue, tip of nose, lips, eyelids, skin, thyroid gland, penis, placenta and endometrium of uterus.

Functions of the A-Vanastomosis (shunt):

1. Regulation of body temperature, as in skin, they dilate on exposure to cold.
2. Regulation of venous return.
3. Regulation of blood flow in the organs.
4. Regulation of digestion, absorption and secretion in the digestive system.



LYMPH VESSELS

Excess tissue fluid (lymph) is drained by lymph vessels to be returned to the circulation.

- Lymph vessels are found everywhere except in nervous system and bone marrow

Lymphatic Capillaries:

- Begin with a blind end.
- Are larger than blood capillaries.
- Made of endothelium, resting on a thin basement membrane.
- Have no pericytes in their walls.

Lymphatic Vessels:

- Similar to Venules, but they have larger lumina.
- Lymph nodes are found along their course.

Lymphatic Ducts:

- Similar to veins in structure.
- Media contains smooth muscle fibres.
- Adventitia contains vasa vasorum.

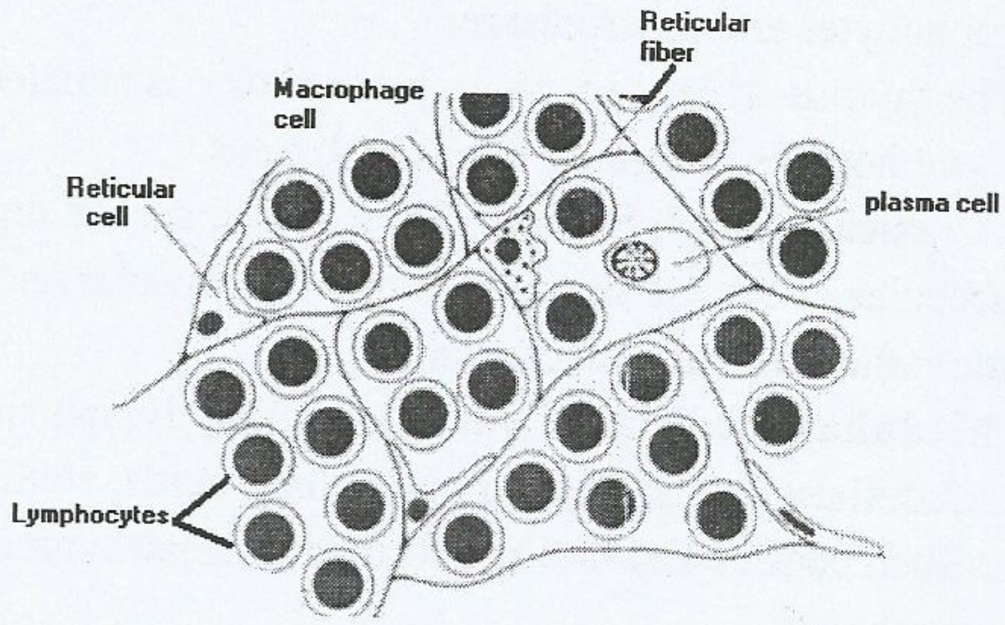
THE LYMPHATIC SYSTEM

Formed of either nodular or diffuse aggregations of lymphocytes.

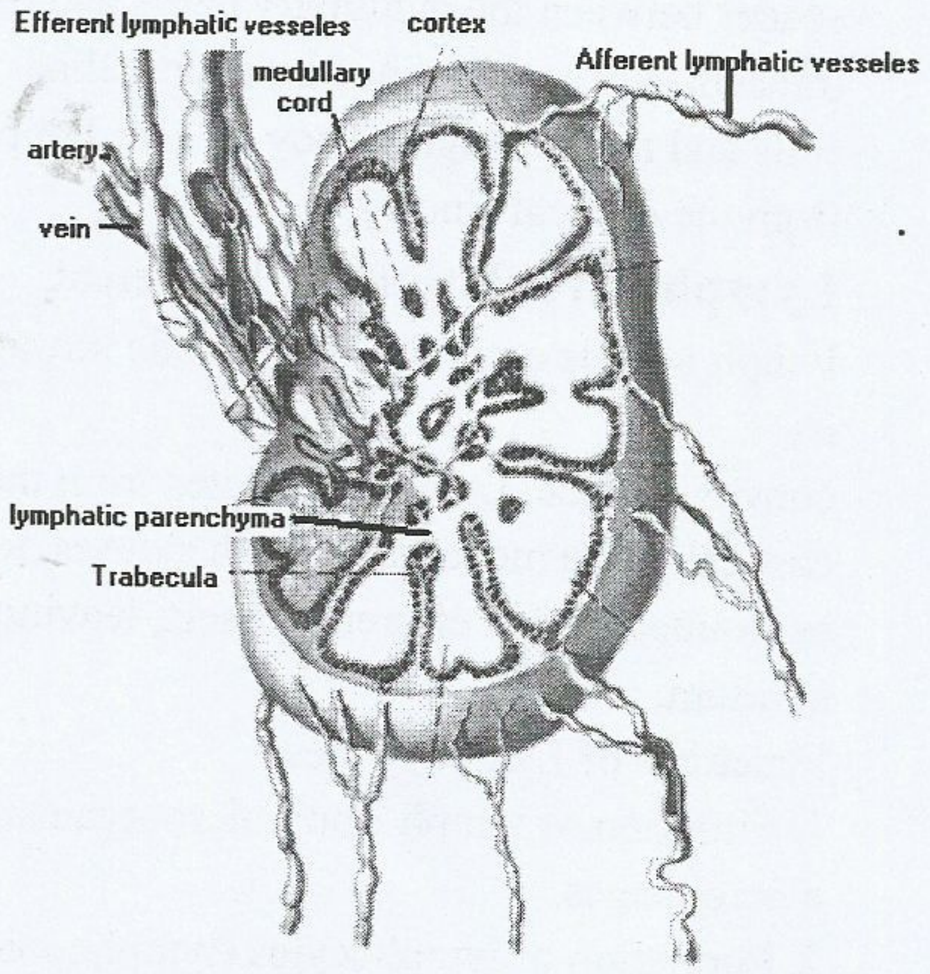
Diffuse lymphatic tissue is met everywhere in the loose C.T., e.g. corium of small intestine.

Lymphatic nodules are spherical accumulations of lymphocytes.

The largest lymphoid aggregations are found in lymph nodes, spleen, tonsils, thymus and Peyer's patches of the ileum.



LYMPH NODES



They are small kidney-shaped bodies, present singly or in groups along the course of lymph vessels. Groups of lymph nodes are found in neck, axilla and groin. Lymph nodes **Made of stroma and parenchyma**.

A- Stroma: (capsule, trabeculae & reticular stroma)

1. Capsule: is thin and formed of collagen fibres and fibrocytes. It may contain smooth muscle fibres. It is usuallysurrounded by adipose tissue.
2. Trabeculae (septa): extend from the deep surface of the capsule, dividing the cortex into regular compartments. In medulla, they branch and anastomose dividing the medulla into irregular compartments. They are formed of collagen fibres and fibrocytes.
3. Reticular Stroma: forms the background of the organ and is continuous with the capsule & trabeculae. It is made of reticular cells and argyrophilic (stains with silver).

B. Parenchyma: (cortex & medulla)

1. Cortex: (lymph follicles & cortical lymph sinuses)

a) Lymph Follicles (Nodules):

- Rounded aggregations of small lymphocytes (mostly B) occupying the compartments between the trabeculae.

Are either primary or secondary nodules.

▶**Primary nodules** (without germinal centres) are formed of densely packed cells (mainly B-lymphocytes, few T-lymphocytes, antigen-presenting cells and reticular cells).

▶ On exposure to antigen, primary nodules change to secondary nodules.

Secondary nodules (follicles) have peripheral dense regions of small lymphocytes and pale germinal centres (containing large lymphocytes, lymphoblasts, plasmablasts, plasma cells, reticular cells, T-lymphocytes and macrophages).

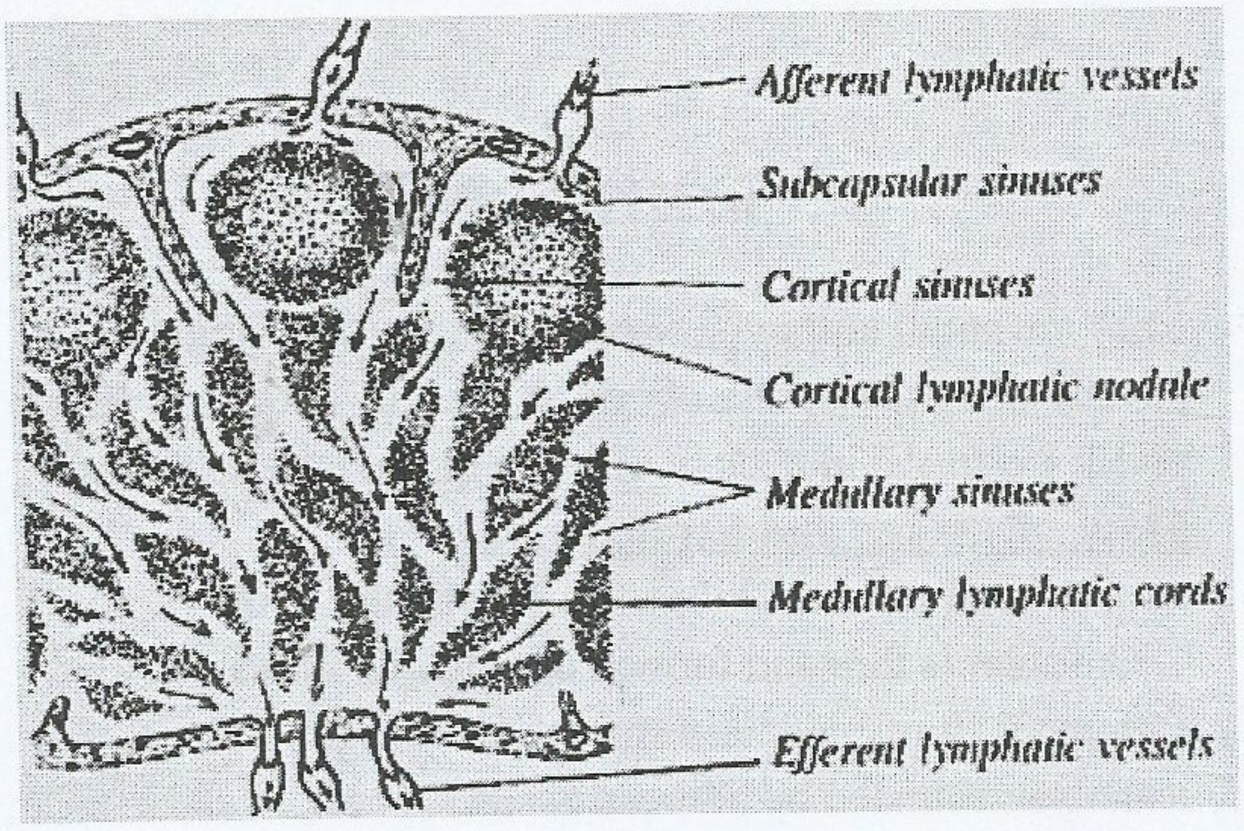
- The thymus-dependent zone (paracortex): is situated between the cortex and medulla. They contain T-lymphocytes, migrated from the thymus.

b) Cortical Lymph Sinuses: They are the spaces separating the lymph follicles from the capsule and trabeculae. They are subdivided into subcapsular and trabecular sinuses. They are lined by endothelial cells and macrophages.

2. Medulla: (medullary cords & medullary lymph sinuses)

a) Medullary Cords: They are branching cords, continuous with the cortical nodules. They have no germinal centres and they are formed of small lymphocytes, plasmablasts, plasma cells and macrophages.

b) Medullary Lymph Sinuses: They are the spaces between the medullary cords and the trabeculae. They are lined by endothelial cells and macrophages. They receive lymph from the cortical sinuses.



Lymph Circulation: 10-12 afferent lymph vessels enter the lymph node through its convex surface. Lymph circulates from the cortical to the medullary lymph sinuses, to be drained by 1-2 efferent vessels, leaving at hilum.

Functions of Lymph Nodes:

1. Filtration of lymph from microorganisms & foreign bodies, by the phagocytic action of macrophages.
2. Formation of lymphocytes (lymphopoiesis).
3. Immunological functions:

a) Humoral immunity: antigens activate the change of B-lymphocytes to plasma cells. Antibodies secreted by plasma cells circulate in blood stream and reach the site of the antigen.

b) Cell-mediated immunity: antigens activate the T-lymphocytes to change to killer cells, which secrete lymphokines to destroy the antigen.

SPLEEN

the largest lymphatic organ in the body.

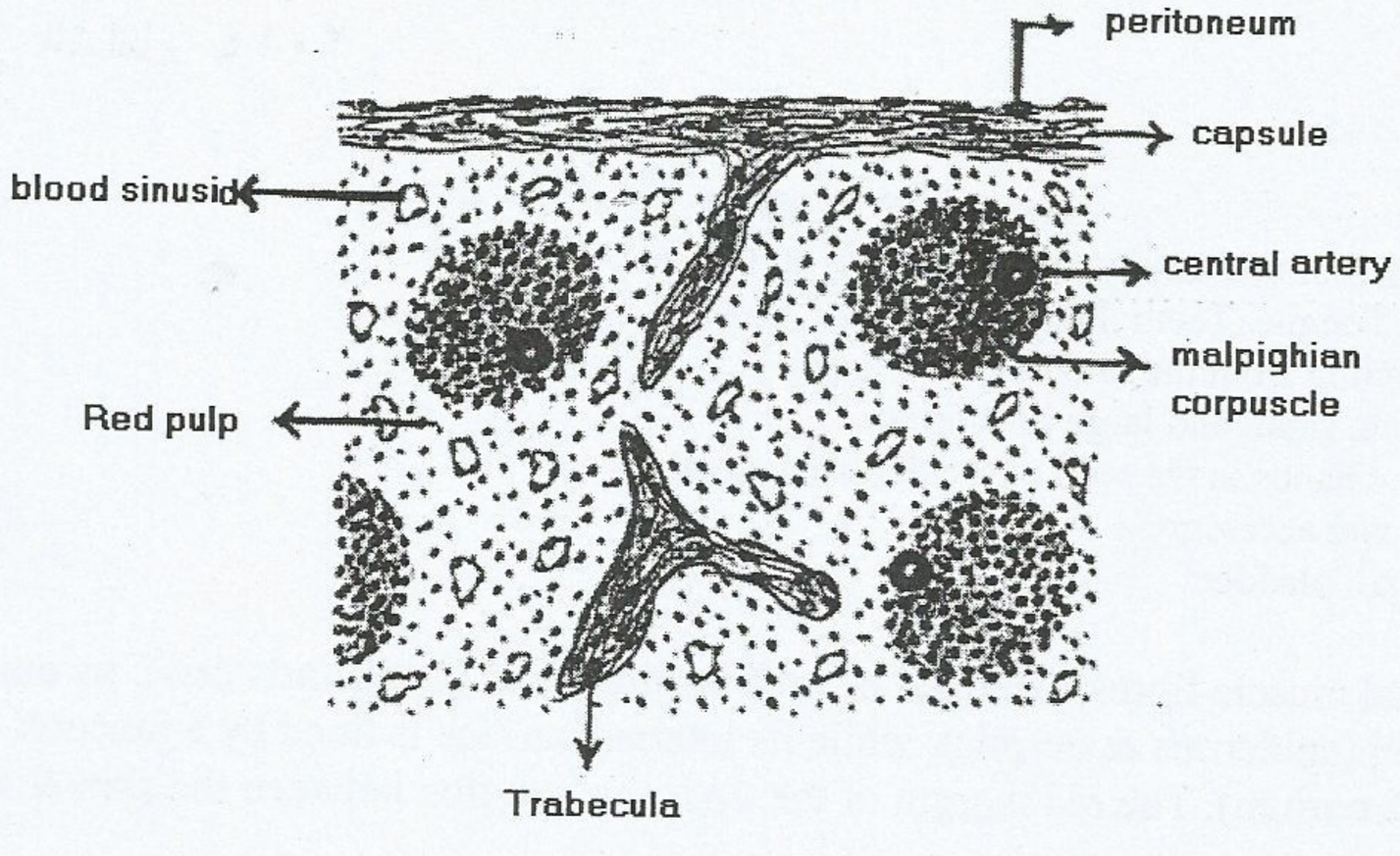
found in the abdomen along the course of blood stream (haemolymphatic organ).

formed of stroma and parenchyma.

A. Stroma: Capsule, is thick, Trabeculae (septa), formed of dense C.T. and Reticular stroma, forms the background of the organ

B. Parenchyma: (white and red pulps)

1. White Pulp: splenic nodules with central artery.
2- Red pulp: splenic cords or Billroth cord and venous sinusoids.



The spleen main functions are
- Production of blood cells, such as lymphocytes; (in the fetus the spleen also produces granulocytes and erythrocytes);
- Destruction of the erythrocyte by the macrophages of the red pulp cords;
-Defense of the organism since it contains both "B" and "T" lymphocytes and macrophages; (splenic "B" may give rise to antibody-producing 'plasma cells);
-Storage of blood, due to the spongy structure of the red pulp of the spleen
-store blood, which can be returned to the circulation to increase the volume of circulating blood. In humans the blood storage capacity is very small.

Tonsils:

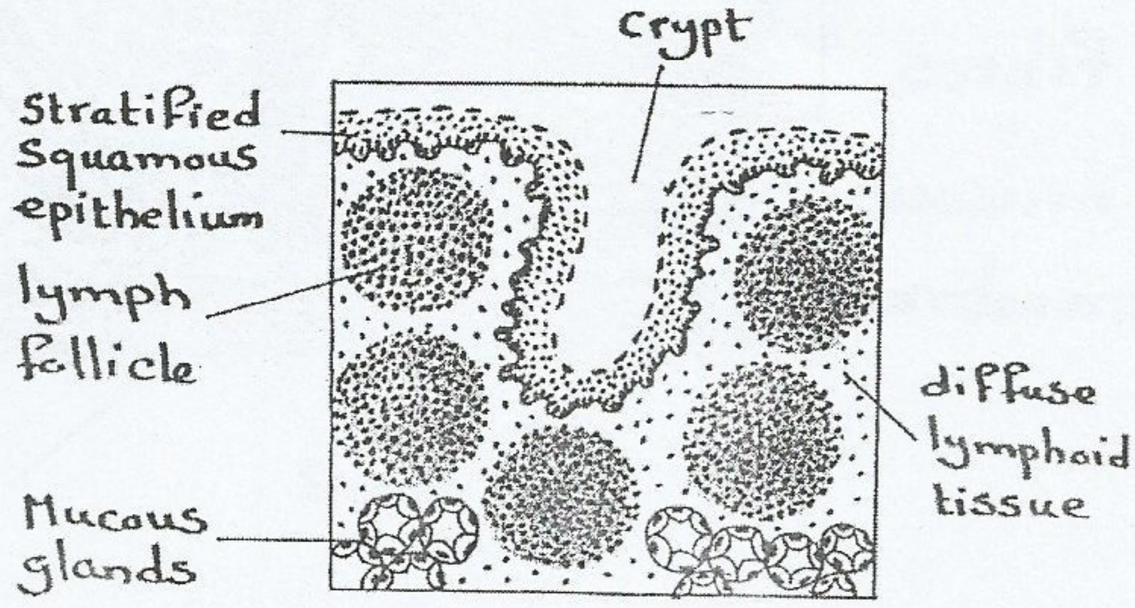
There are three groups of tonsils, the palatine tonsils, the pharyngeal tonsil and lingual tonsils .
They are aggregations of lymphatic tissue in mucous membranes.

1. The Palatine Tonsils: They are 2 masses of lymphoid tissue embedded in the mucous membrane of the pharynx. They are covered by stratified squamous epithelium, which sends deep invaginations or crypts into the substance of the tonsil. The lymphatic nodules are arranged in a single layer around the crypts. They show germinal centres (secondary nodules). Diffuse lymphoid tissue is scattered between the nodules. Mucous glands are found deep to the lymph follicles. The deep aspect of the palatine tonsil is surrounded by a C.T. capsule. Lymphocytes can penetrate the epithelial covering, to mix with the. saliva (salivary corpuscles).

2. The Pharyngeal Tonsils (Adenoids): They are embedded in the mucous membrane of the nasopharynx. The lymphoid tissue is mainly diffuse and the epithelium is pseudostratified columnar ciliated epithelium with goblet cells.

3. The Lingual Tonsils: They are found at the base of the tongue. They are covered by stratified squamous epithelium, which forms deep crypts.

Functions of the Tonsils: Protection of the digestive and respiratory systems against bacteria, by production of antibodies.



Digestive system

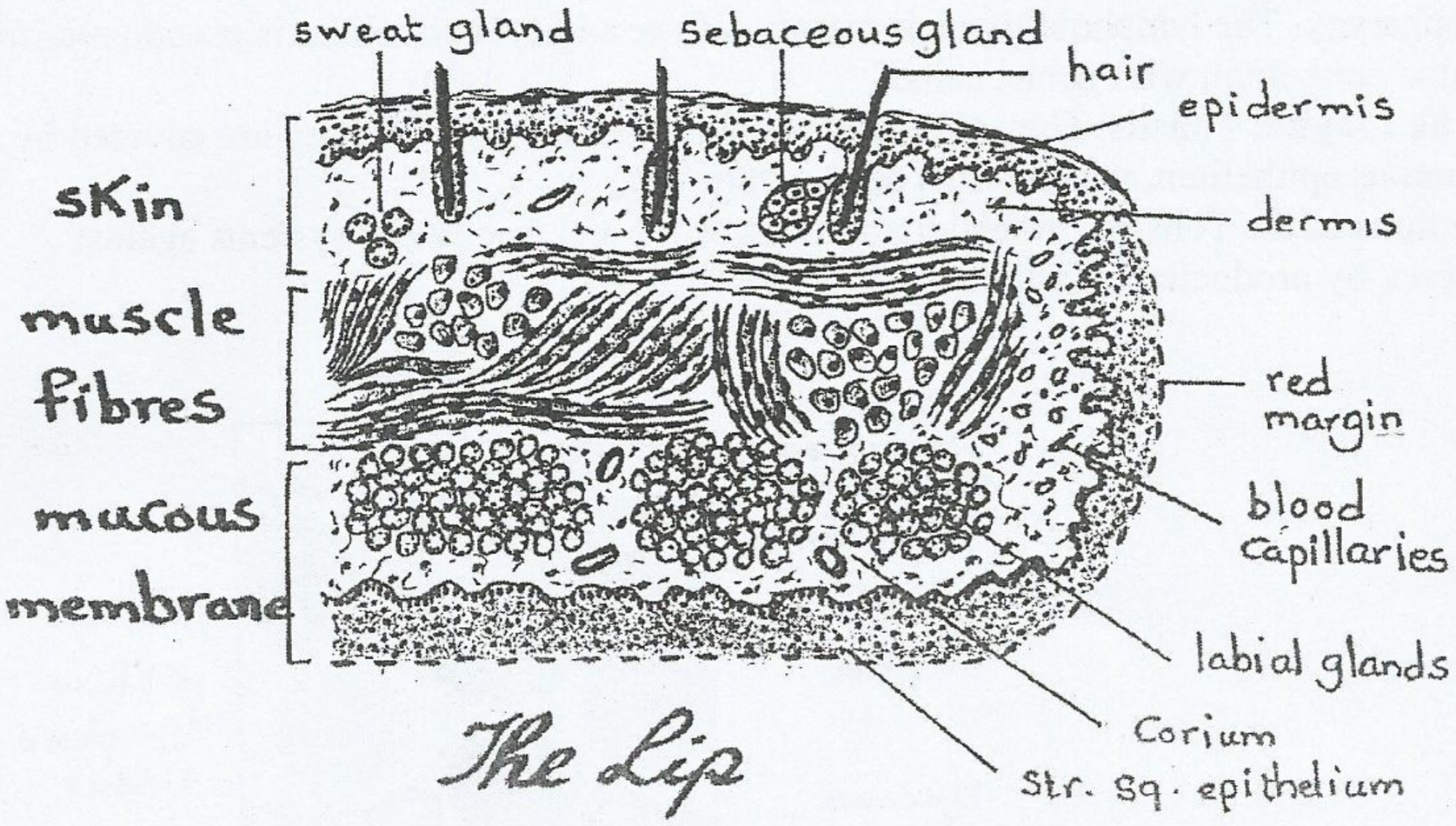
Digestive system is composed of oral cavity, digestive tract and glands.
1-Oral cavity: lips, cheeks ,Tongue ,Teeth ,Palate ,Pharynx.
2-The digestive tract: Extending from the oral cavity to the anus.
pharynxEsophagus, stomach, small and large intestines.
3-and its associated glands: Glands in the wall of the digestive tract.
the salivary glands.(major and accessory-)
pancreas the liver and the gall bladder

LIP

The lip is made of skeletal muscle fibres, arranged in various directions (orbicularis oris). Its outer surface is covered by skin (epidermis & dermis), while its internal surface is lined by a mucous membrane (epithelium & corium). The red margin of the lip is the junction between the skin & the mucous membrane.

SKIN OF LIP	MUCOUS MEMBRANE
➢ covered by keratinized stratified squamous epithelium. ➢ contains hairs & hair follicles. ➢ its dermis contains sweat and sebaceous glands. ➢ poor blood supply. ➢ thin, dry & opaque.	➢ covered by non-keratinized stratified squamous epithelium. ➢ contains no hairs or hair follicles. ➢ its corium contains mucoserous glands, the labial glands. ➢ rich blood supply. ➢ thick, wet & transparent.

The Red Margin (vermillion zone): It is covered by modified skin with no hair follicles, sweat or sebaceous glands. The C.T. dermis forms deep papillae, that contains numerous blood capillaries & receptors.



The Lip

THE TONGUE

The tongue is a mass of striate muscle fibers that cross one another in the 3 space plane. They are grouped in bundles separated by
connective tissue.

The tongue is covered by a mucous membrane strongly adherent to the muscle by the connective tissue of the lamina propia that is continuous to the connective tissue surrounding the muscles.

Within this connective tissue there are mucous, serous and mixed glands.

On the lower surface of the tongue, the mucous membrane is smooth.

The dorsal surface is rough surface, separate in two parts by a "V" shape sulcu:

-The anterior two-thirds: shows a rough mucous membrane covered by a great number of small papillae.

-The posterior one third: presents small lymphoid aggregations and the lingual tonsils.

Papillae are elevations of the dorsal tongue epithelium and lamina propria.

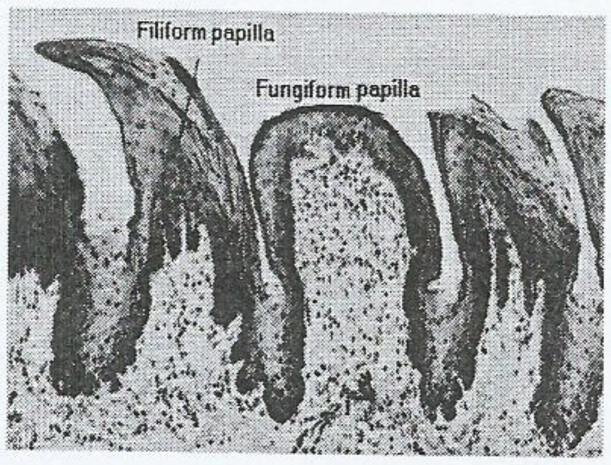
There are 4 types of the papillae:

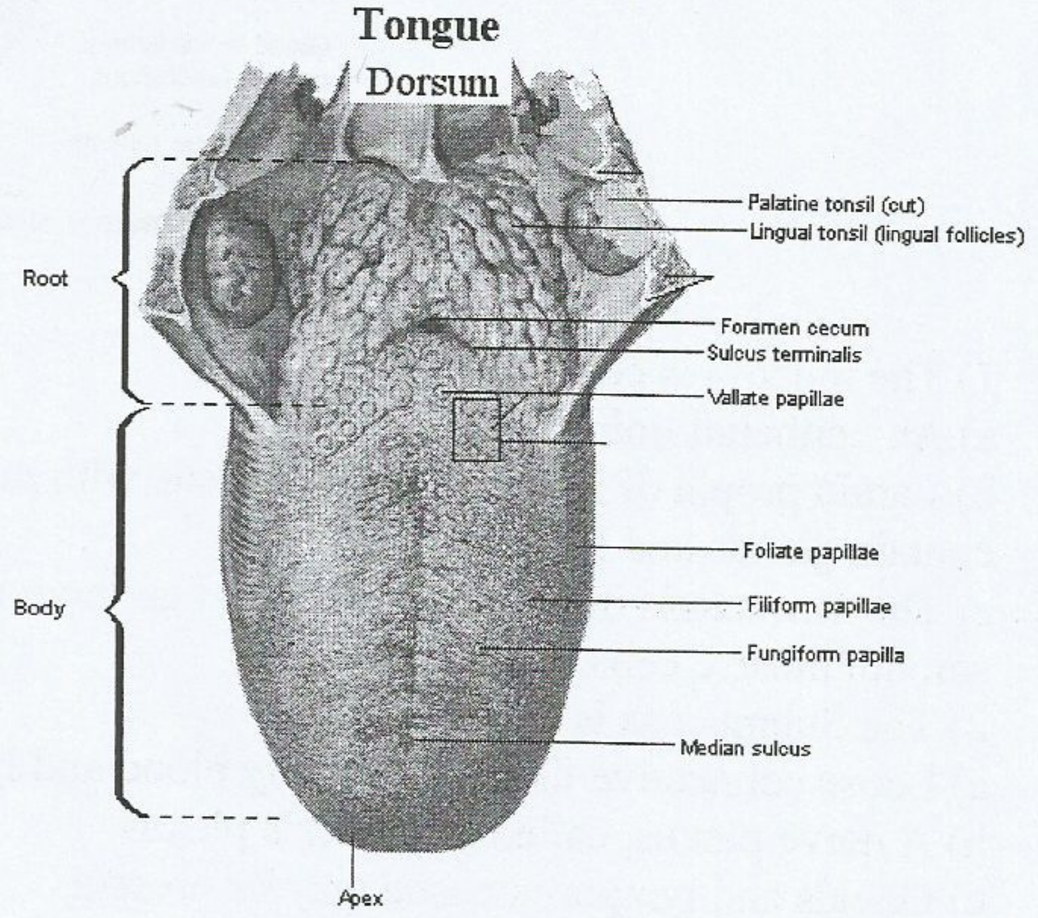
1- Filiform papillae: Have conical shape; they are very numerous over the entire surface of the tongue. Their epithelium is partly keratinized.

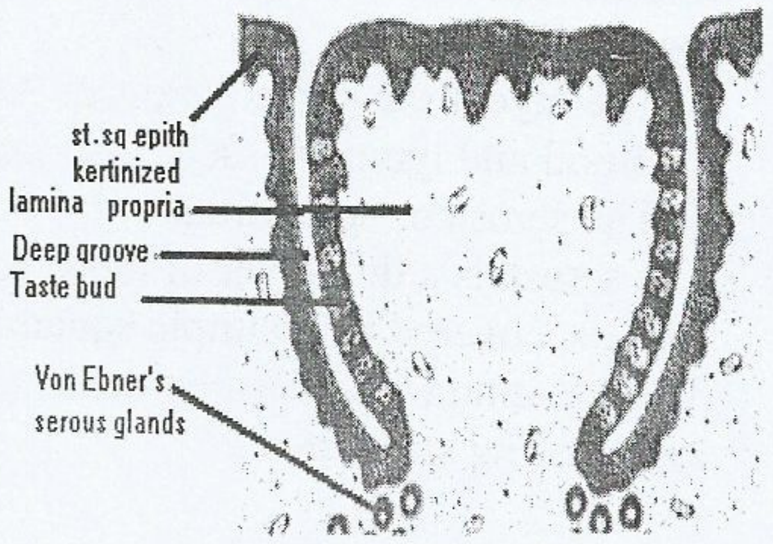
2- Fungiform papillae: Are fungus-shaped, have a narrow stalk and a dilated upper part. These papillae contain scattered taste buds and are among the Filiform papillae.

3- Circumvallates papillae: Are large circular papillae. There are only 10 tol4 circumvallate papillae distributed along the "V" sulcus. Many serous glands (Von Ebner) drain into the deep groove that encircles each papillae providing a continues flow of fluid over the taste buds present along the sides of each papillae.

4- Foliated papillae: Are poorly developed in humans, as leaf-like folds present at the postero-lateral.







cirumvallate papillal

THE PHARYNX

-It is a transition space between the oral cavity and the respiratory and digestive systems.

-The pharynx is lined by stratified squamous epithelium, contains the tonsils and has many small mucous glands in its dense connective tissue.

-There is muscle tissue located outside this layer.

TUB ULAR DIGESTIVE TRACTUS

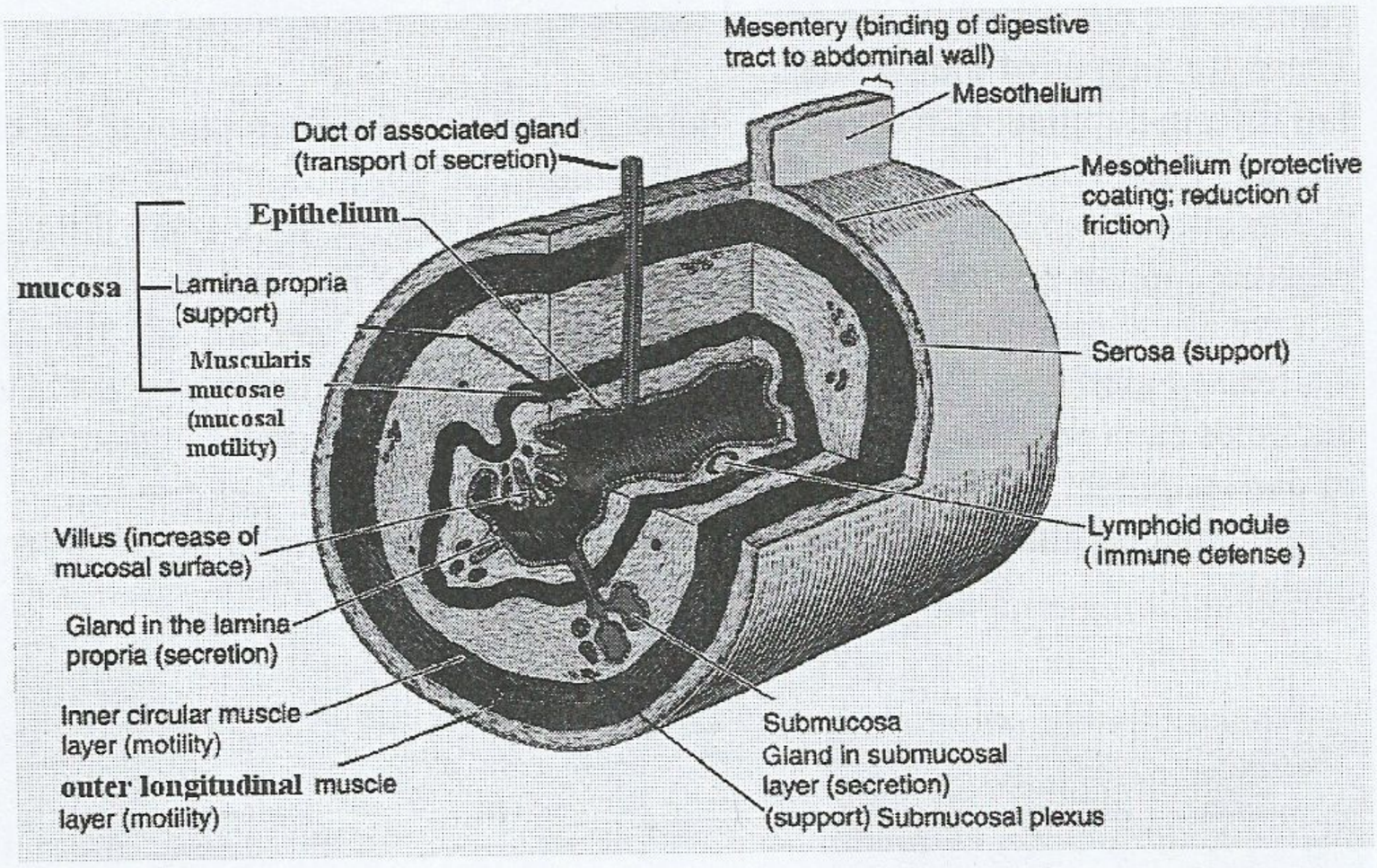
It is composed by:

1) esophagus.
2) stomach.
3) small and large intestine. General structure:

The digestive tract is a hollow tube and presents common characteristics.

Its wall is made up of 4 layers:

1) The mucosa.
2) The sub mucosa.
3) The muscularis externa.4)
The serosa or the adventitia.



1) The mucosa is composed of:

a) An epithelial lining

b) Lamin propia of loose connective tissue with many blood and lymphatic vessels, also it may contain glands and lymphoid tissue.

c) The muscularis mucosa: consisting of an inner circular and an outer longitudinal layer of smooth muscle cells.

2) The Submucosa is composed of

a) Loose connective tissue with many blood and lymph vessels .

b) A nerve plexus, called Meissner's plexus.

c) Glands and lymphoid tissue may be present

3) The muscularis externa is composed of the following element:

a) Smooth muscle cell, divided into two layers; the internal circular layer and the external longitudinal.

b) The myenteric nerve plexus or Auerbach's, present between the 2 muscle layers.

c) Blood and lymph vessels: also present in the connective tissue between the muscle layers.

4) The serosa or adventitia.

The serosa is a thin layer of loose connective tissue and adipose tissue, rich in blood and lymphatic vessels, covered by a simple squamous epithelium (mesothelium).

The adventitia is formed by dense elastic connective tissue continues with the connective tissue of surrounding structures.

This part of the digestive system is a muscular tube whose function is to transport food from the mouth to the stomach.

Esophagus:

It has the layers described in the general structure:

1) The mucosa is covered by nonkeratinezed stratified squamous epithelium which its lamina propria presents vessels and few lymphatic nodules, the muscularis mucosa is thick.

2) sub-mucosa presents tubulo-alveolar mucous glands, vessels and nerve plexus within its connective tissue.

3) The muscularis externa close to pharynx has striated skeletal voluntary muscle. In the mid-portion a mixture of striated and smooth muscle cells. At the distal third portion the muscularis externa consists of only smooth muscle cells.

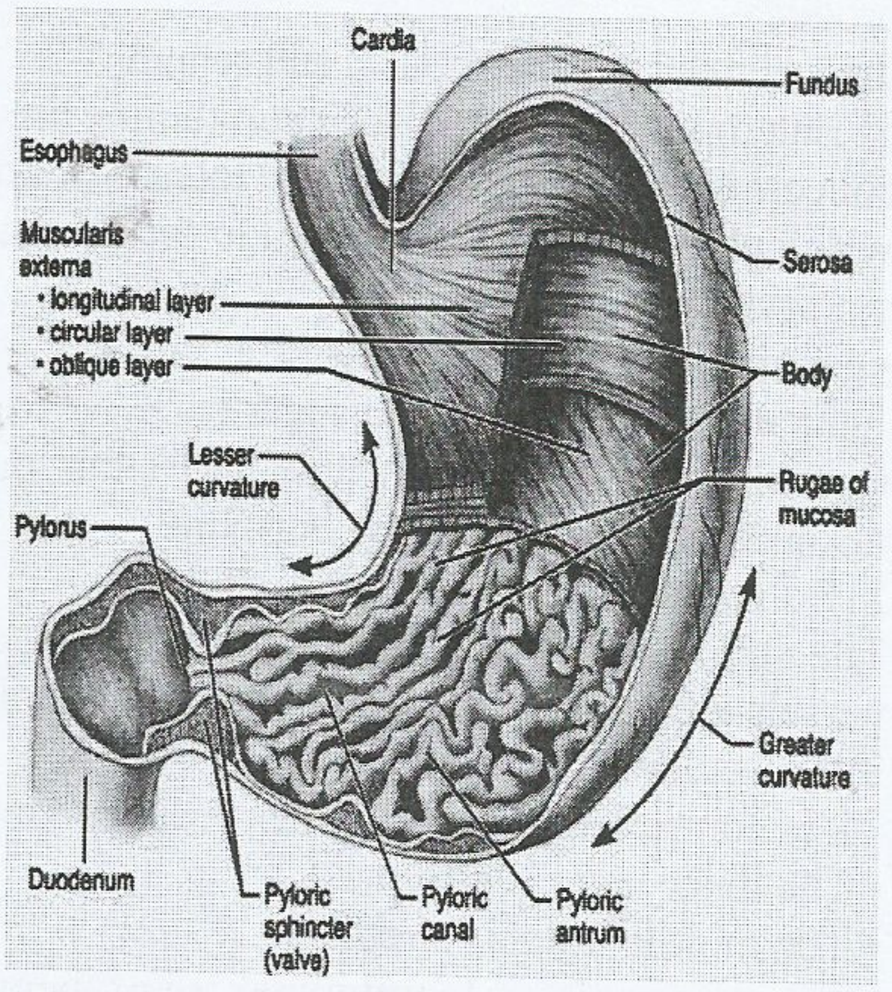
4) The outer layer is a serosa in the peritoneal cavity.

The rest of the esophagus is covered by a layer of loose connective tissue. The adventitia, continuous to the connective tissue of the-surrounding structures.

Stomach:

- The stomach continues the digestive process begun in the oral cavity.

Have 4 regions: cardiac, fundus, body, and pylorus. The fundus and body are identical in microscopic structure. The stomach is a dilated segment of the tubular digestive tract whose main functions are to add an acidic fluid, mucous and enzymes such as pepsin (for proteins) ; Rennin (curdle milk) and lipase (stars fat digestion) to the ingested food and transform it by muscular activity into a viscous mass, the chyme.



The gastric mucosa consists of:

1) A surface simple columnar epithelium which all its cells secrete mucus (neutral glycoprotein) forms a film that protects these cells from the acid secreted by the stomach. The epithelium invaginate into lamina propia forming gastric pits. Emptying into gastric pits are tubular glands.

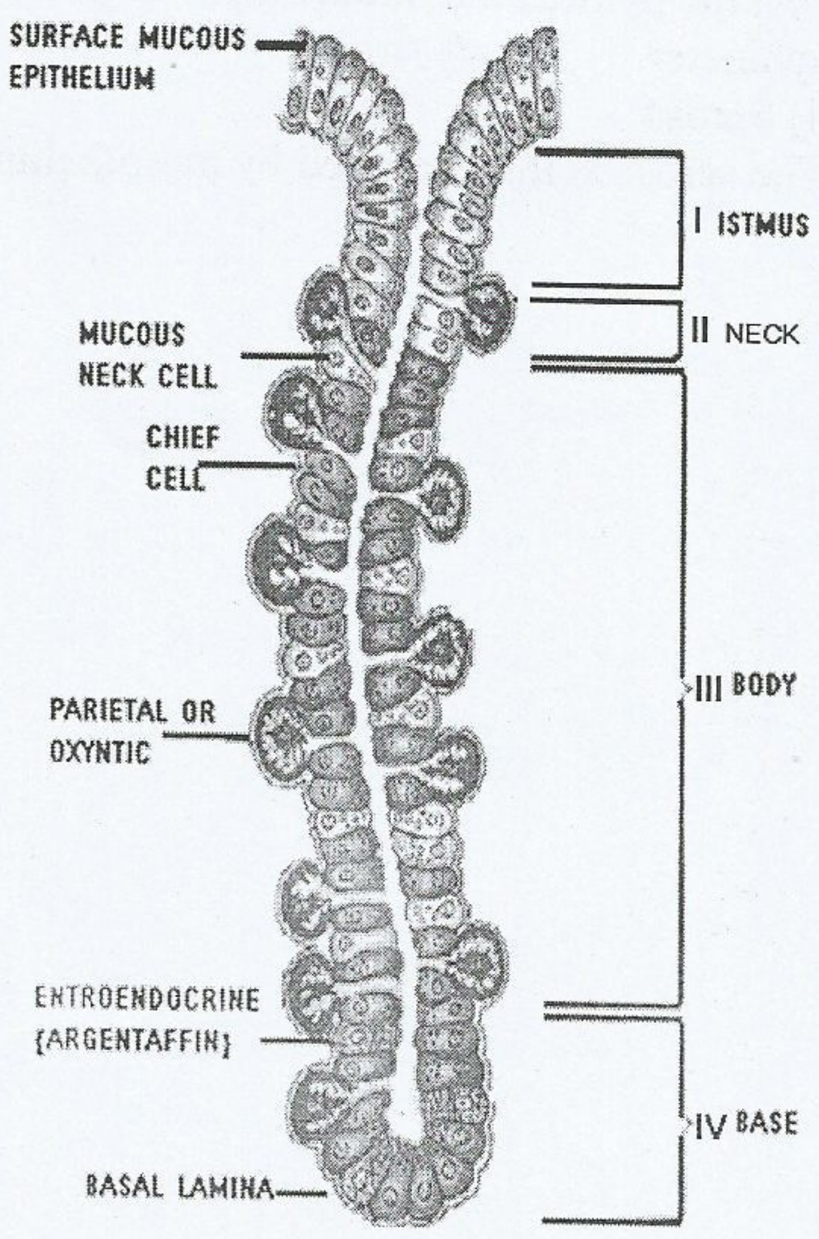
2)The lamina propia which main characteristic is the presence of numerous gastric glands, emptying into gastric pits, and scattered loose connective tissue between the glands where smooth muscle and lymphoid cells are present.

3)The muscularis mucosa that is a layer of smooth muscle cells composed of inner circular layer, an outer longitudinal layer and a more external layer of oblique muscle fibers in some regions.

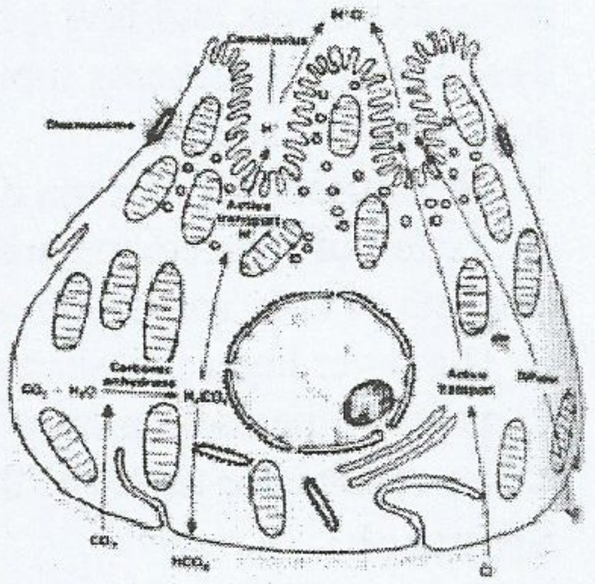
Gastric glands:

Fundus and body glands: the lamina propia of these regions is filled with branched tubular gastric glands, which open into the bottom of each gastric pit. The gastric glands has isthmus, close to the pits, the neck and the base (or body).

The distribution of epithelial cells is not uniform in the gastric glands and there are the following types of cells:



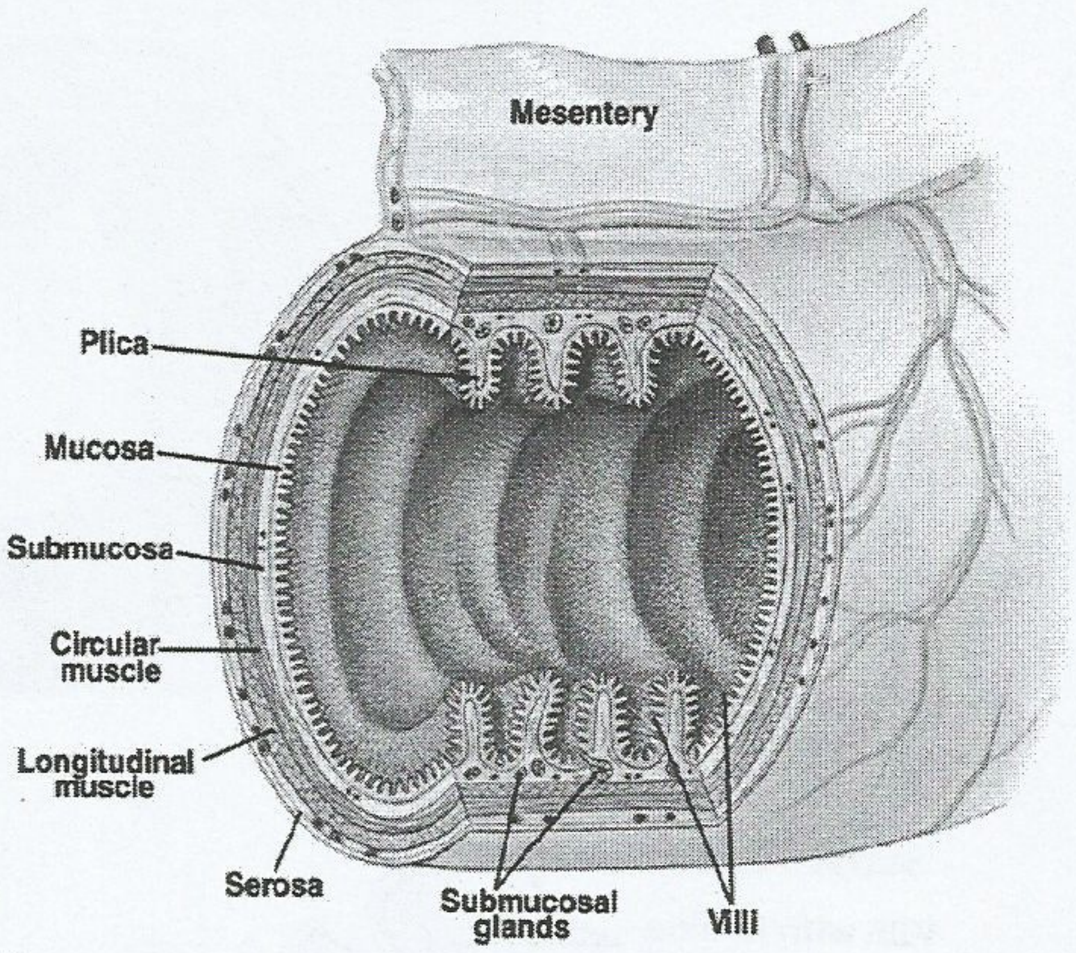
1) Undifferentiated cells: found in the isthmus. some of them differentiate and move upward to replace the pit and surface mucous cells. Other cells migrate deeper into the gland and differentiate into the mucous neck cells, parietal cells, chief cells or enteroendocrine cells,
2) Mucous neck cells: They are located in the neck, secrete an acid mucous.
3) Parietal cells: (or oxyntic - acid forming) are present atthe isthmus, neck and scarce in the glands base., and ofintensely acidophil cytoplasm. Upon observation in theelectron microscope there are invaginations of the apical cellintracellular canaliculus that increase the cell surface area.



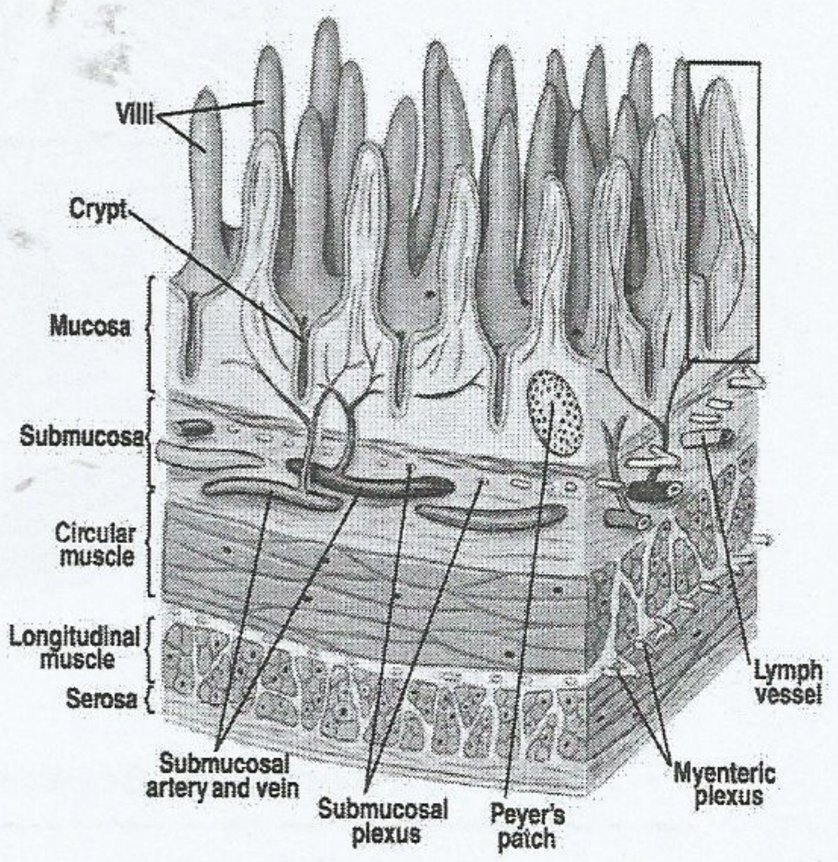
Parietal cell secretethe hydrochloric acid and intrinsic factors binds to vitamin B12. the presence of intrinsic factor is required for vitamin B12 absorption by the cell of the small intestine. The lack of intrinsic factor leads to vitamin B12 deficiency. This disease is a disorder of the red blood cell- formation known as pernicious anemia.
4) Chief (zymogenic) are present at the base of gastric glands These cells produce
the enzymes pepsin , lipase, and rennin
5) Enteroendocrine or APUD cell (amine precursor uptake and decarboxylation) which are concerned in the production and release of hormones. Enteroendocrine cells secrete hormones all of which pass via the blood stream to their target organs. The main enteroendocrine cells type at the stomach are:
• gastrin that stimulates (secretion of HCL.
- glucagon increases blood sugar level.
• gastric inhibitory polypeptide (GIP), that inhibits the gastric acid secretion.
• Somatostatin : antigrowth hormone
2) Submucosa: -
The Submucosa is composed of loose connective tissue where blood and lymph vessels are present; it is infiltrate by lymphoid cells.
3) Muscularis externa:
- It is composed of smooth muscle fibers arranged in 3 main directions:
• The inner layer is oblique.
• The middle layer is circular.
• The external layer longitudinal, all of them are thick.
• At the pylorus the middle layer is greatly thickened to form the Pyloric sphincter.
4) Serosa
The serosa is thin, covered by mesothelium

SMALL INTESTINE

- The process of digestion is completed in the small intestine and the products of digestion are absorbed.
- The small intestine consists of 3 segments: duodenum, Jejunum and Ileum, approximately 6 meters long.
- The 3 segments have many characteristics in common and will be discussed together.



Intestinal surface area is enhanced by finger-like villi.



Mucosa has the following specialization:

a) The plicae circulares its folds include entire thickness of mucosa and portion of the submucosa. Increase the surface area.

b) Intestinal villi . These structures are outgrowths of the mucosa (epithelium around core of lamina propia) projecting into the lumen of the small intestine assuming a finger- shape form. At the lamina propia connective tissue, there are arterioles, venules and lymphatic vessels. Villi increase the surface area.

c) intestinal glands or crypts of lieberkuhn

d) Between the bases of the villi are the opening of simple tubular glands. They evagniation into the lamina propia up to the muscularis mucosae. The epithelium of the villi is continuous with that of the glands.

Lamina Propia

-The lamina propia of the Small intestine is composed of loose connective tissue with blood and lymphatic vessels, nerve fibers and some smooth muscle cells.

-in addition there are lymphoid follicles more numerous at ileum where they may occupy the thickness of the mucosa separated from the lumen only by the simple columnar epithelium as long as there are no villi or crypts on the surface of large follicles called the Peyer's patches.

Muscularis mucosae

It follows the general structure pattern; an inner circular layer and an outer longitudinal layer of smooth muscle cells.

2) The submucosa

-the submucosa may be infiltrated with lymphocytes in the region of Peyer's patches.

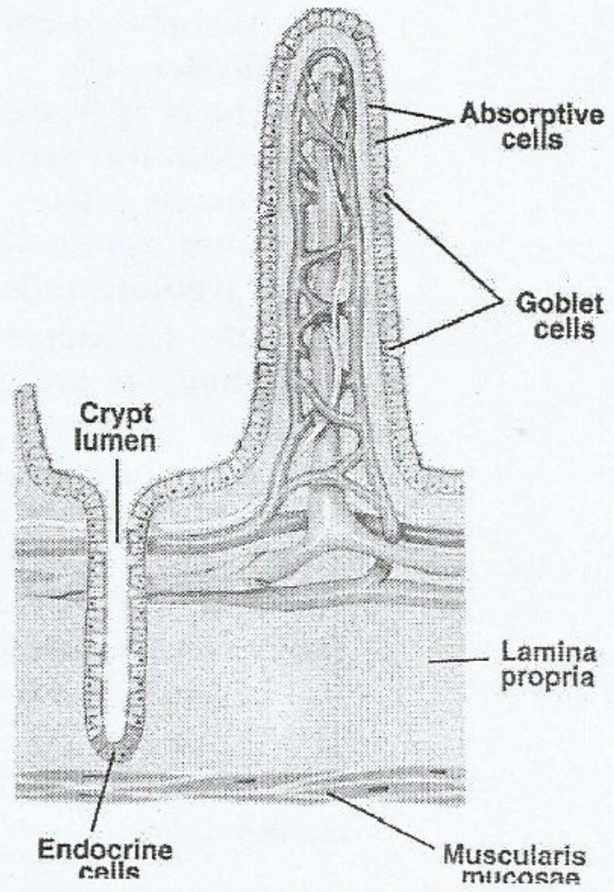
-in the duodenum there are the Brunner's glands. These glands, Secrete alkaline mucus. That neutralizes the acidity of the chime coming from the stomach.

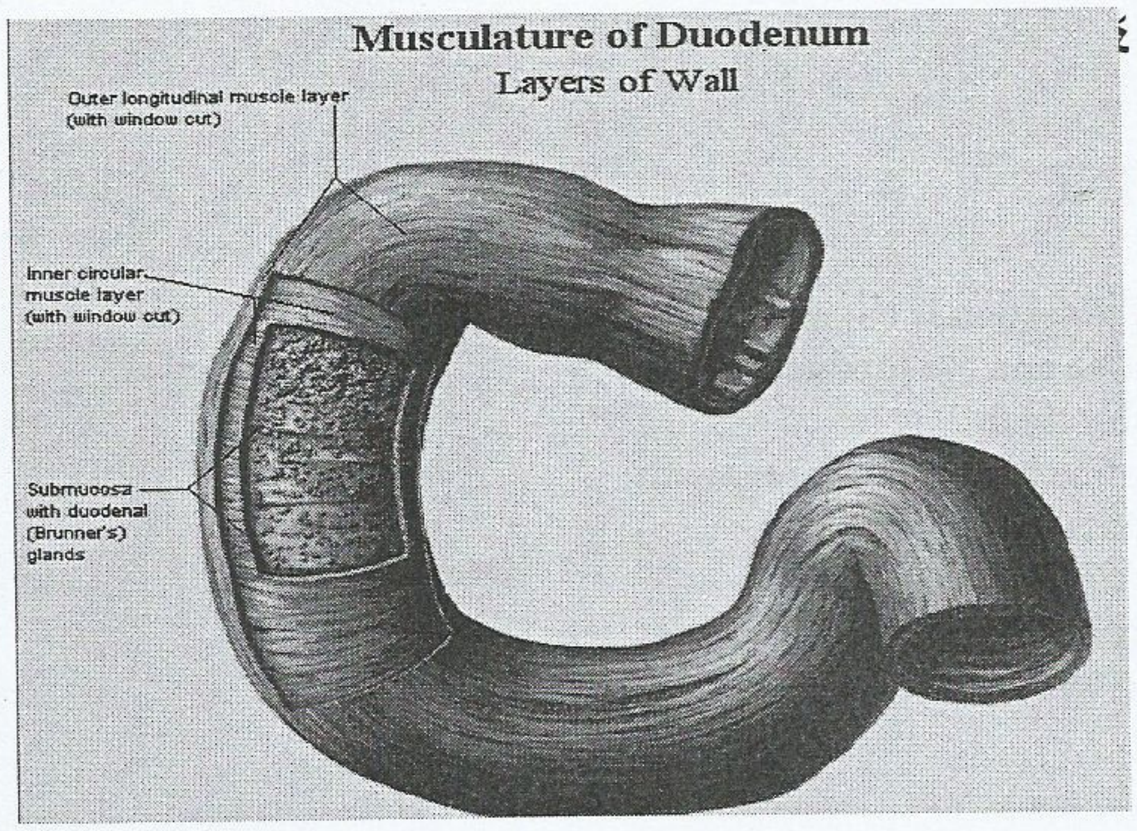
-The submucosal nerve plexus is present.

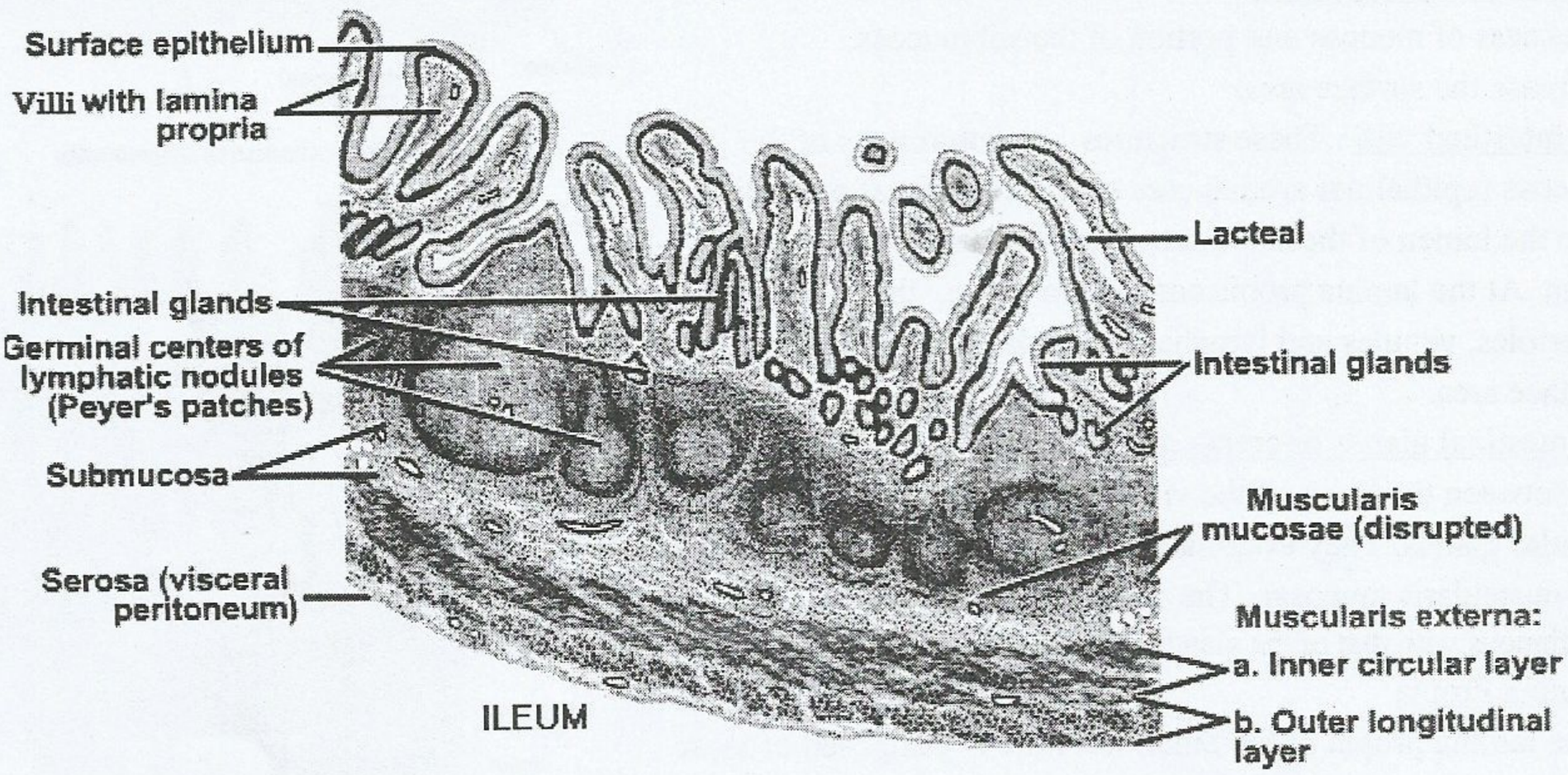
3- muscularis externa

Muscularis externa does not present any peculiarity in this organ. have the general structure pattern, including the Auerbach's nerve plexus.

4) Serosa:The serosa has the typical structure.







Differences Between Small And Large Intestine

Small Intestine	Large Intestine
1. It is about 6 meters in length.	1. It is about **180 cm** in length.
2. It has a **small** diameter.	2. It is larger in diameter.
3. Anatomically it is formed of duodenum, jejunum and ileum.	3. Anatomically it is formed of caecum, colon and rectum.
4. Its mucosa is formed of **villi** and **crypts.**	**4. Its mucosa is formed of longer crypts, but with no villi.**
5. The villi are covered with:- a) Absorptive columnar cells b) Goblet cells The crypts are lined with:- c) Columnar stem cells d) Paneth cells e) Entero-endocrine cells f) Caveolate cells	5. The crypts are lined with:- a) Simple columnar absorptive cells b) Many goblet cells c) Columnar stem cells d) No paneth cells e) Entero-endocrine cells f) Caveolate cells may be present.
6. Globule leucocytes, plasma cells and Lymphocytes are present between the crypts	6. Solitary lymphatic nodules and diffuse lymphocytes are present between the crypts
7. Submucosa of duodenum contains **Brunner's glands,** while **Peyer's patches** are present in the mucosa of ileum.	7. No glands and no lymphoid follicles are present in the submucosa of large intestine.
8. The inner circular and outer longitudinal **muscles** are continuously surrounding the wall of small intestine.	8. The inner circular muscles are well developed, while the outer longitudinal form three separate bundles known as **taenia coli** on the **outer surface of the colon.**
9. **Serosa** formed of C.T. and simple squamous mesothelium.	9. Serosa formed of masses of adipose C.T. covered with simple squamous mesothelium forming the **appendices epiploicae.**

THE MAJOR DIGESTIVE GLANDS

The major digestive glands are:* the pancreas and the liver and salivary glands
There are 3 major salivary glands:

* The parotid.
* The submandibular.
* The sublingual.
  - In addition to the small glands present at the lips, cheeks and tongue.

The liver:

- The liver is the largest gland of the body, weighing about 1.5 kg.
- Most of its blood (70%) comes from the portal vein (small intestine) the rest is applied by the hepatic artery.
- Material absorbed via the intestine reach the liver through the portal vein or by lymph vessels

Functions

The liver is essential to life Its functions are:

1) related to blood glucose concentration.
2) lipid metabolism;
3) store glycogen, vitamin A and B, also heparin;
4) secretes bile salts, fibrinogen and plasma albumins;
5) synthesizes cholesterol;
6) important role in detoxification of toxic materials 7) and phagocytosis of particulate materials

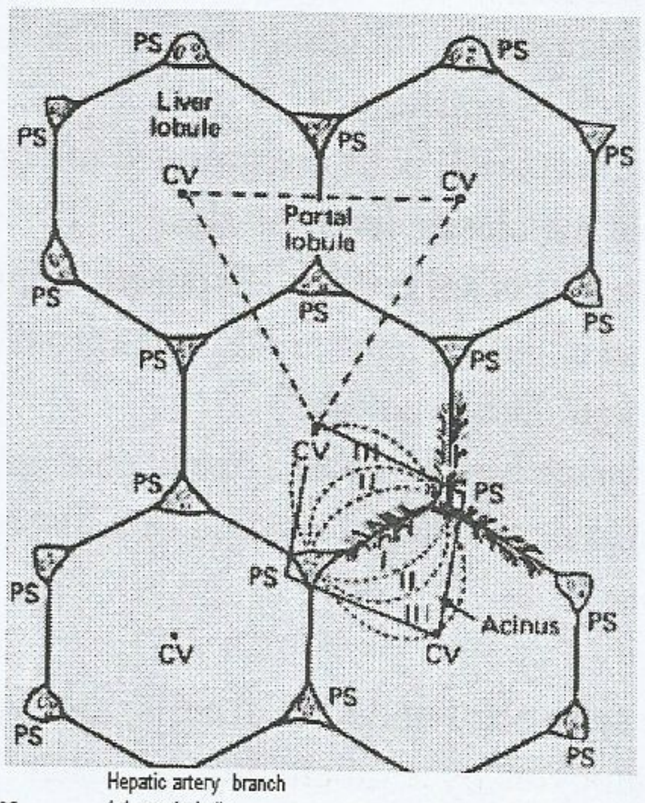
STRUCTURE OF LIVER

Stroma

The liver is covered by a thin connective tissue capsule, Glisson's capsule that becomes thicker at the helium, porta hepatis where the portal vein, hepatic artery and lymphatic vessels enter the liver and the hepatic bile ducts leave the liver.

From the capsule thin septa enter the liver to divide it into lobes and lobules.

A fine reticular fiber network supports the hepatic cells and sinusoids parenchyma



STRUCTURAL AND FUNCTIONAL UNITS OF THE LIVER:

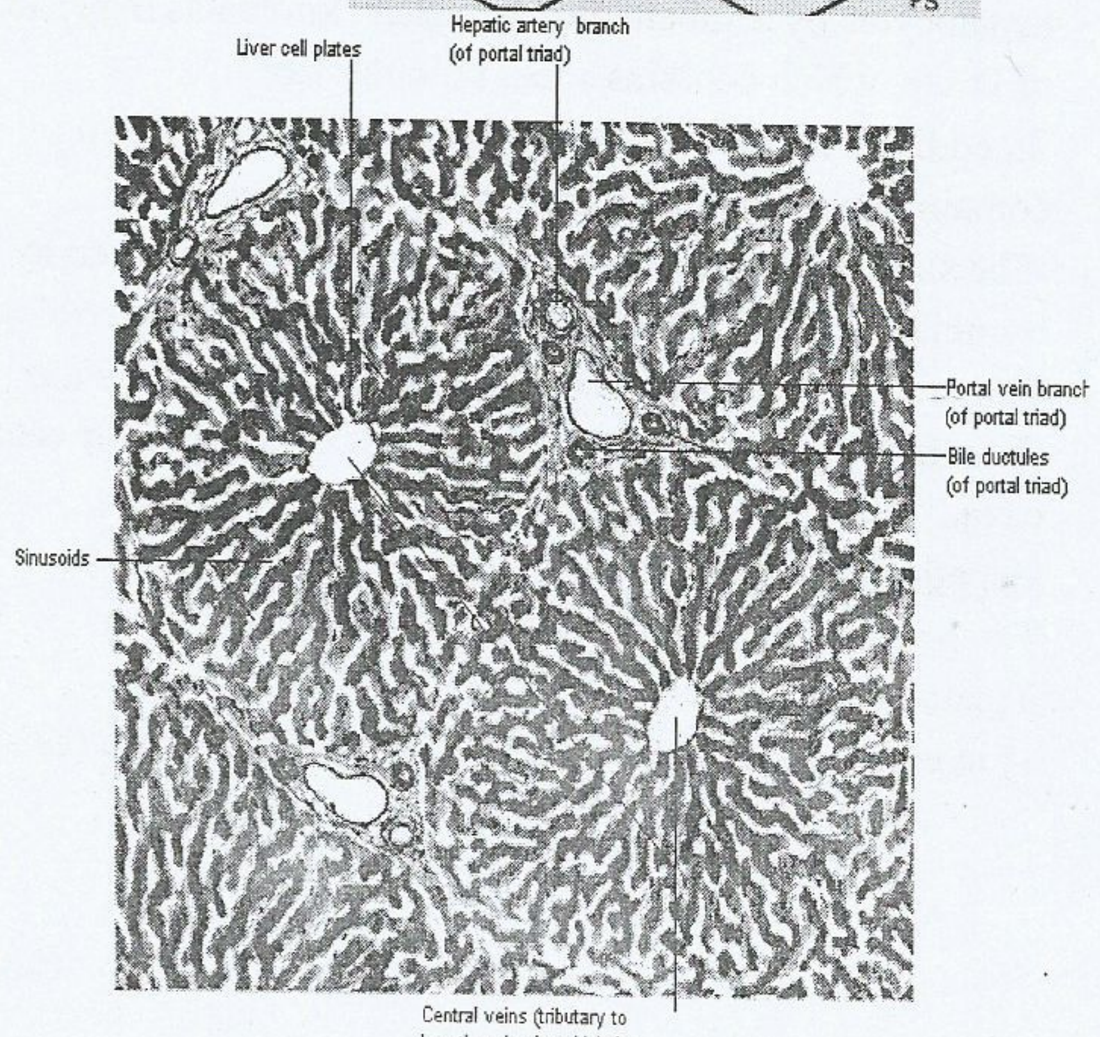
1- Classical lobule.
2- Portal lobule.
3- liver Acinus.

the portal lobules: have their center in the portal area and outlines that connect the central veins as triangle. They comprise the portion of the liver from which bile flows to a portal space.

Hepatic acinus as diamond-shape figure comprises the region irrigated by one distributing vein. zonation of the hepatic acinus is indicated by 1,2,3 zones

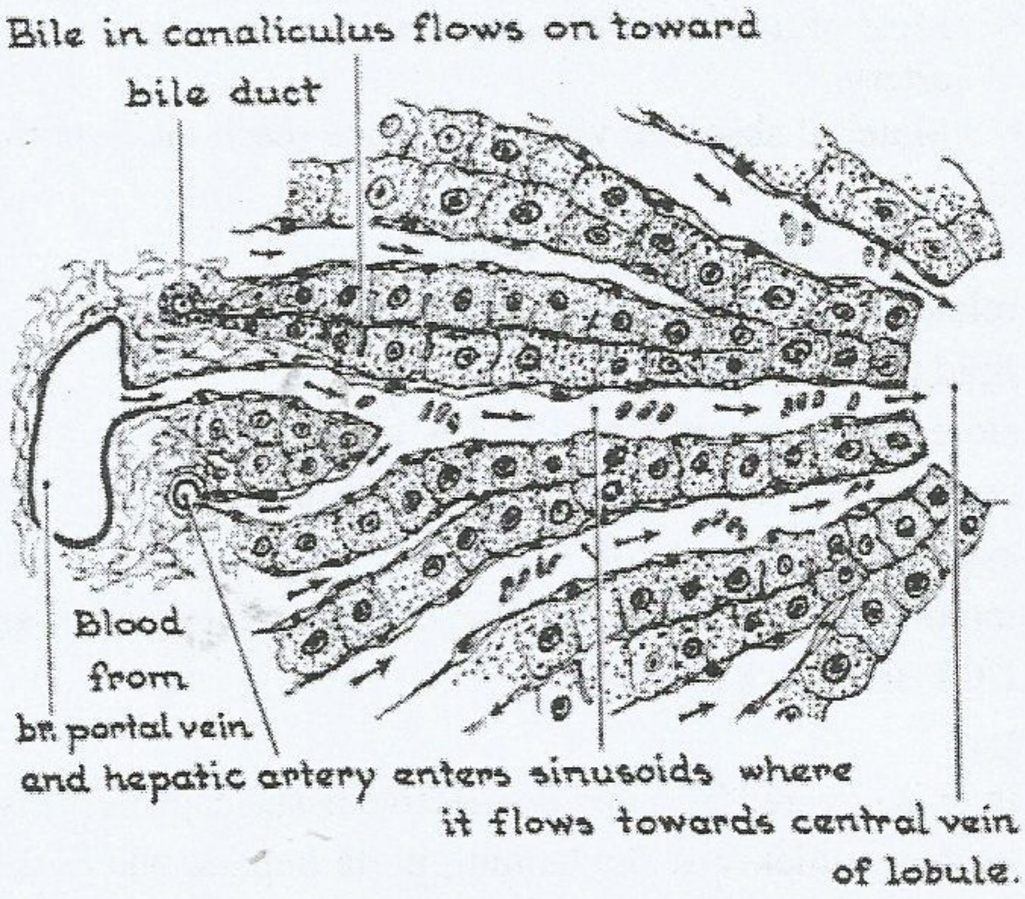
Classical lobule

The liver lobule is formed of a polygonal (or hexagonal prism) mass of tissue



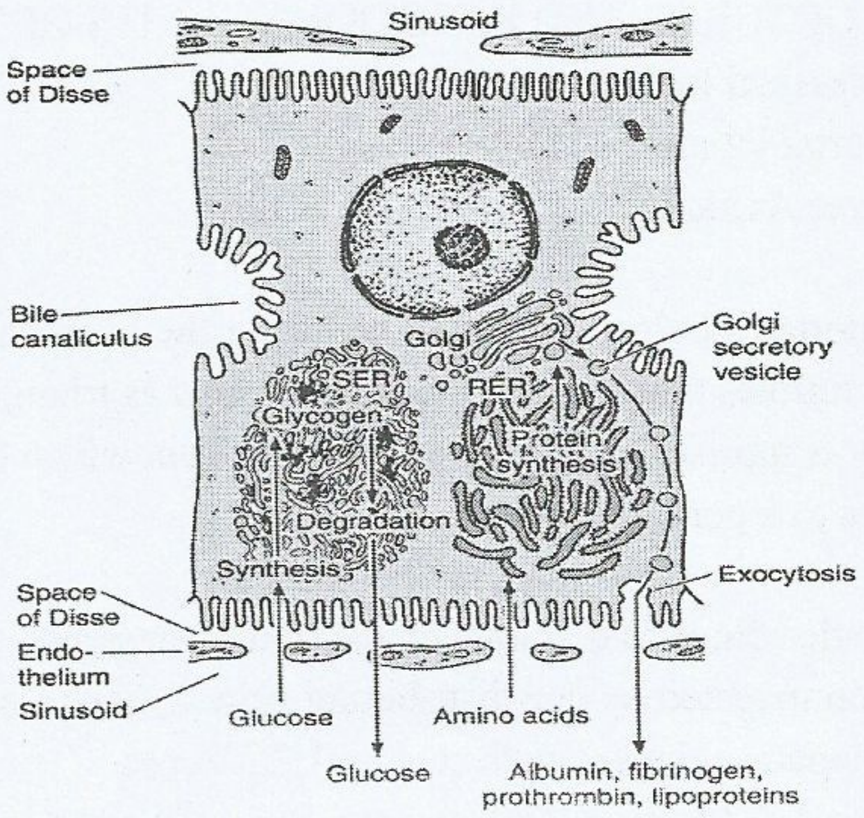
These structural units are called classic liver lobules.
In some animal (e.g. the pig) lobules are separated from each other by a layer of connective tissue. This does not occur in humans the lobules are in close contact making. it difficult to establish the exact limits between different lobules.
At each angle of the classic liver lobule the connective tissue contain bile duct, nerves, lymphatic and blood vessels (arteriole and venule).
These regions are called the portal space or portal areas. All vessels and duct are surrounded by connective tissue from the hilum all the way to the portal areas.
At this point a delicate reticular fiber network is formed to support the hepatic cells and sinusoidal endothelial cells of the liver lobules.

In each portal area present at the corners of the lobules there are the portal triads. Each containing
a) a venule (branch of the portal vein).
b) an arteriole (a branch of the hepatic artery).
c) a duct (part of the bile duct system).
often some lymphatic vessels and nerves are also present at the portal areas.



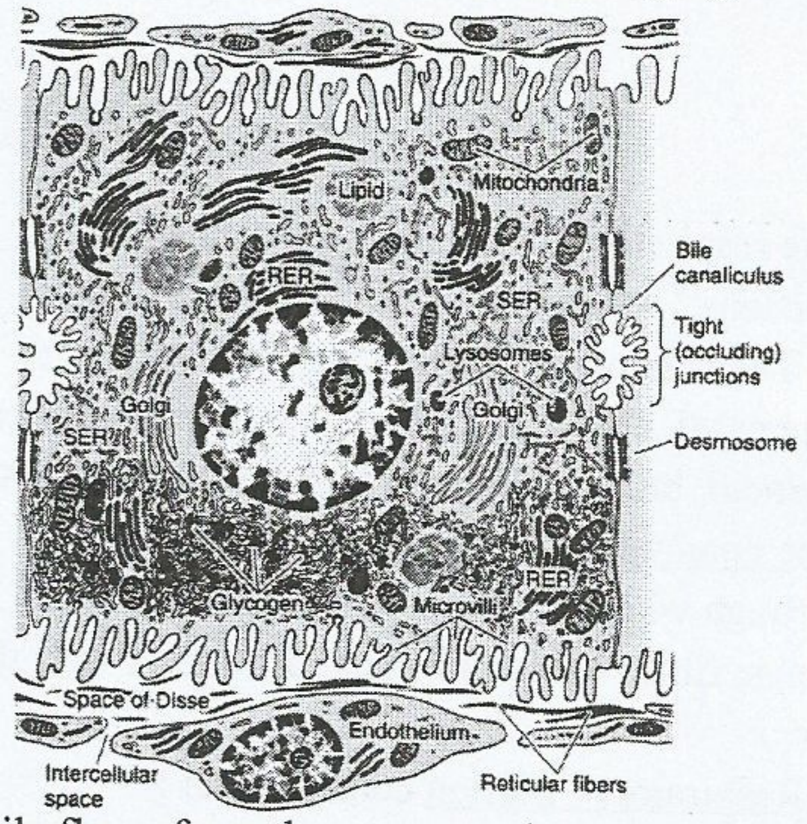
<u>parenchyma</u>
The main structural component of the liver is the liver cell or hepatocyte.
These epithelial cells are grouped in plates or cords within the classic liver lobules.
These cords are radially disposed forming a layer 2 cells thick.
These cellular plates are directed from the periphery of the lobule to its center and anastomose freely, forming a sponge like structure.
The space between these plates contains the liver sinusoid.
Dilated capillaries composed of a discontinuous layer of fenestrated endothelial cells. No basal lamina is present .

The sinusoidal endothelial cells) are separated from the hepatocytes by a subendothelial space, known as the space of Disse, which contains some reticular fiber.
In addition to the endothelial cells, the sinusoids also contain phagocytic cells known as Kupffer cells.
The sinusoid arises in the periphery of the lobule, fed by the terminal branches of the portal vein and hepatic arterioles.
They run in the direction of the lobule center, where they drain into the hepatic veins, tributaries of the inferior vena cava.

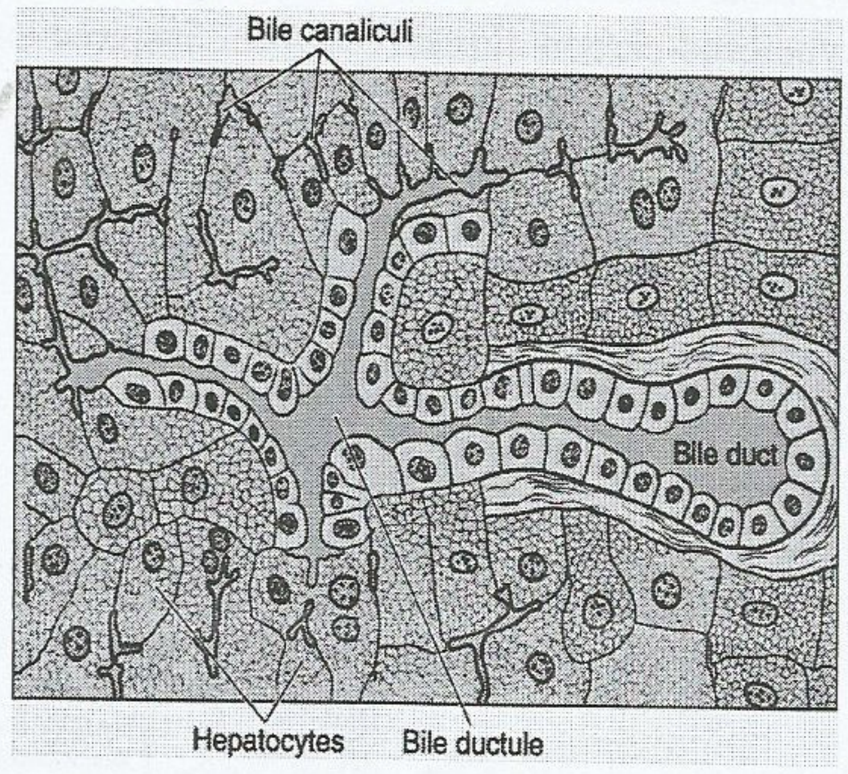


<u>Hepatic cells</u>
The hepatocytes are polygonal, The surface of each hepatocytes may be
1) in contact with the wall of the sinusoids, through the space of Disse

2) with the surface of other hepatocytes.
Wherever 2 hepatocytes are close together, they delimit a tubular space between the two adjacent cell membranes known as the bile canaliculus.

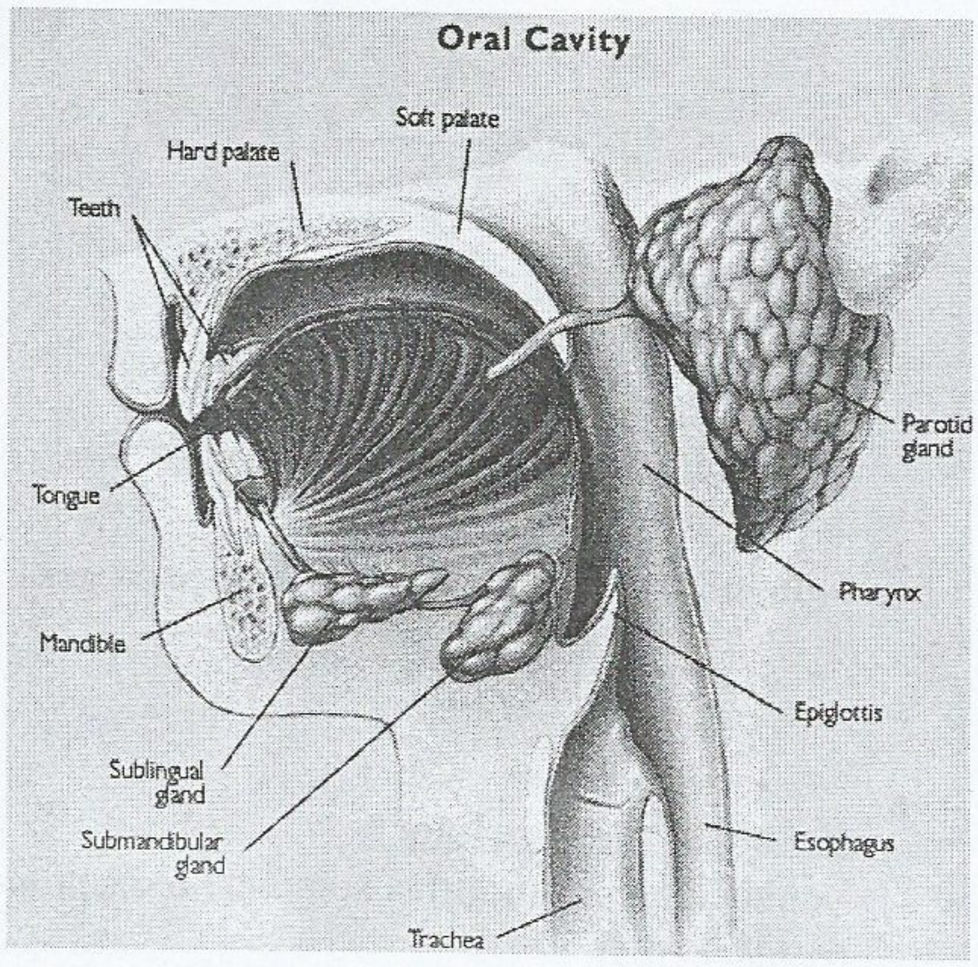


The canaliculi are the first portion of the bile duct system. They are tubular space, limited only by the plasma membrane of 2 hepatocytes and have Microvilli in their interiors.
The bile canaliculi go along the cords of the liver lobule to the region of the porta areas.
The bile progress in a direction opposite to that of the blood, that is, bile flows from the center to the periphery.
At the periphery, bile enters the Herring's canal (or bile ductless) composed of cuboidal Cells.
After a short distance end in the bile duct in the portal triads.
Bile ducts are lined by a simple cuboidal epithelium. They gradually enlarge and fuse forming the hepatic ducts that subsequently leave the liver



Salivary glands

1-Parotid glands:
Its stroma presents a dense connective tissue capsule from which trabecular rise dividing the parenchyma into lobes and lobules.
The parenchyma is composed of **serous acini only**.
and its main duct (Stenon's) opens opposite to the second upper molar.
Their secretion is rich in protein and has amylase
2-Submandibular glands
It's stroma is composed by a dense connective tissue capsule from which septa divides the parenchyma into lobes and lobules.
The parenchyma has **serous and mixed acini**.
That secrete amylase and lysosomes whose main activity is to hydrolyze the walls of some bacteria.
Its main duct (Wharton's) open beneath the tongue.
3)Sublingual glands
Really are many glands beneath the floor of the mouth, each part has a separate duct, are branched tubule-alveolar glands, most acini **are mucous and some mixed.**



RESPIRATORY SYSTEM

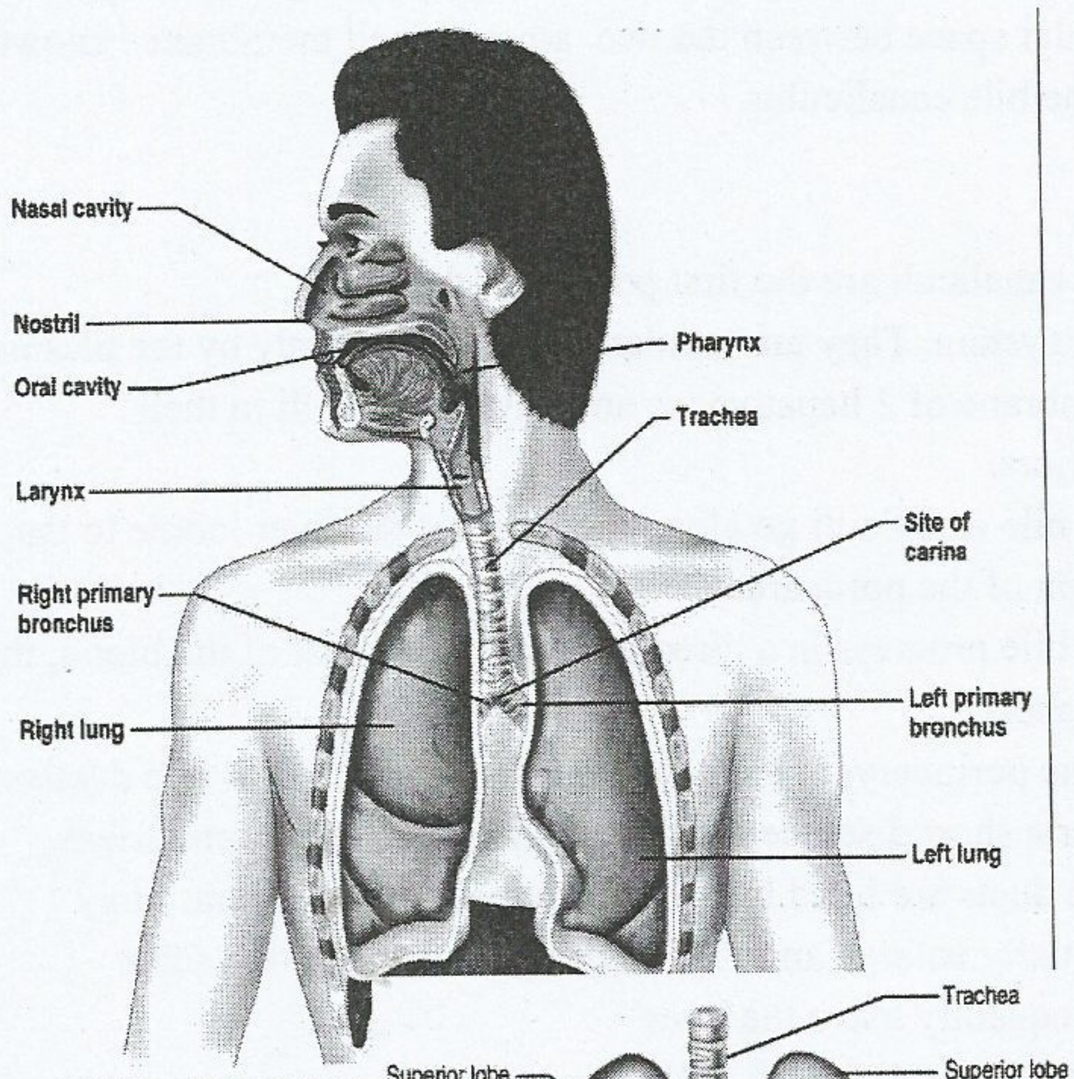
The respiratory system has two principal portions:

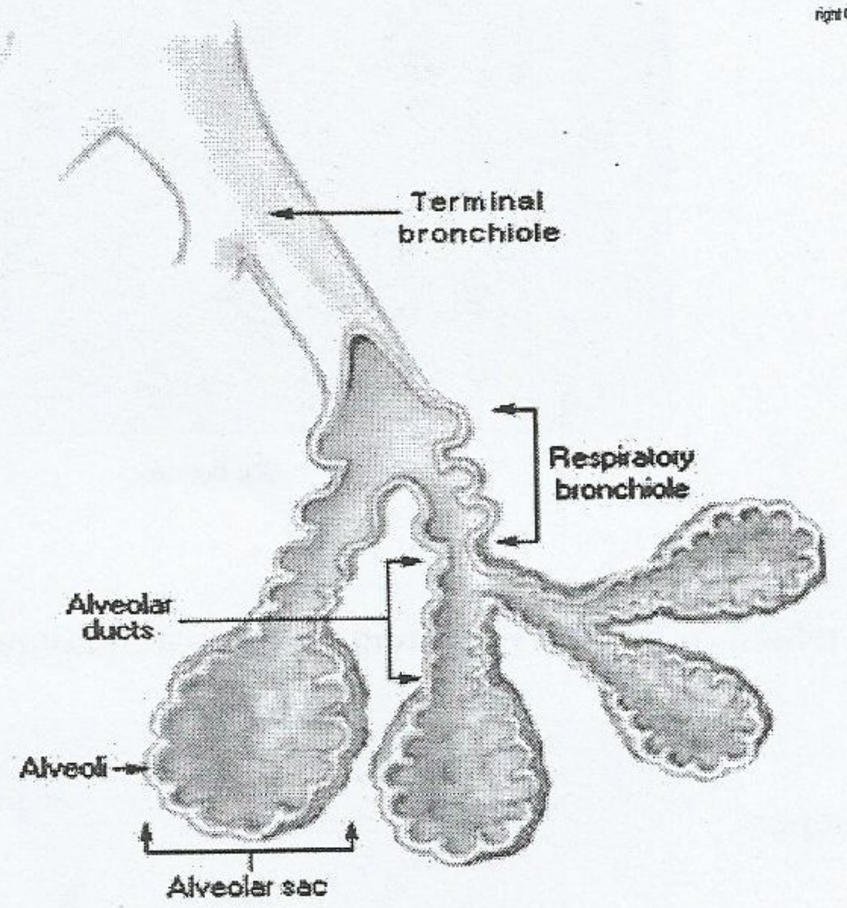
1-The conducting portion are consisting of : the nasal cavity nasopharynx, larynx, trachea, bronchi, bronchioles and terminal bronchioles.

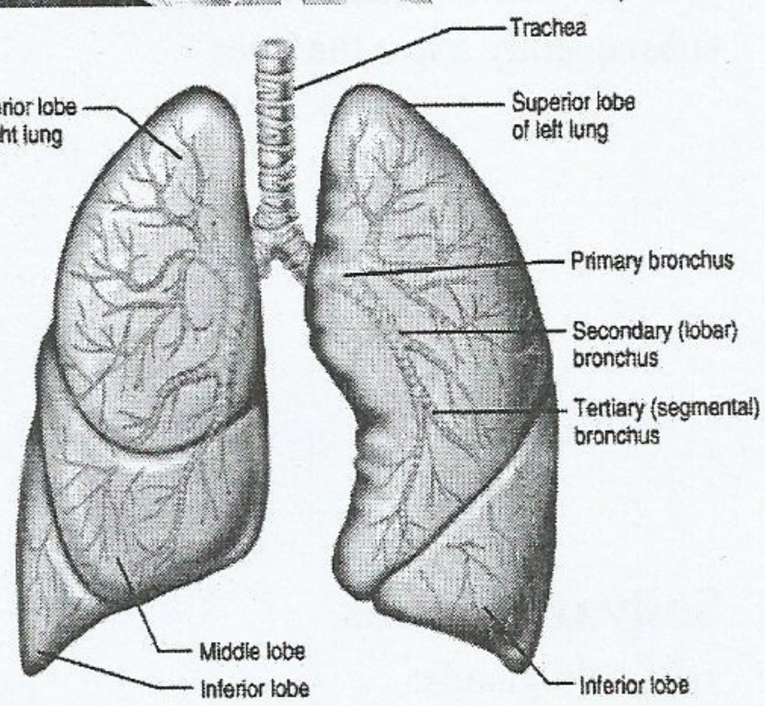
The conducting portion provides passages through which air can travel to and from the lungs, filter, wash, moistenand warm or cool the air.

2-Respiratory portion consisting of : respiratory bronchioles alveolar ducts and alveoli where gas exchange takes place.

Alveoli are the main sites for exchange of the oxygen and carbon dioxide between inspired air and blood.





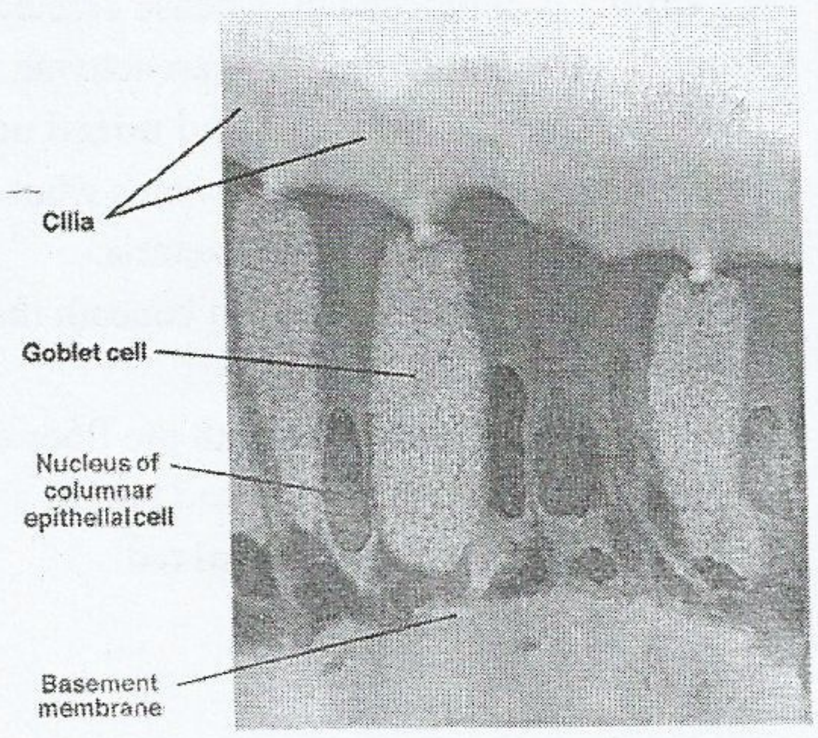


Functions of the respiratory system:

1- Oxygen intake
2- Expulsion of carbon dioxide
3- Sound/voice production
4- Regulation of plasma pH
5- Removal/destruction of airborne pathogens and toxins

Respiratory epithelium :

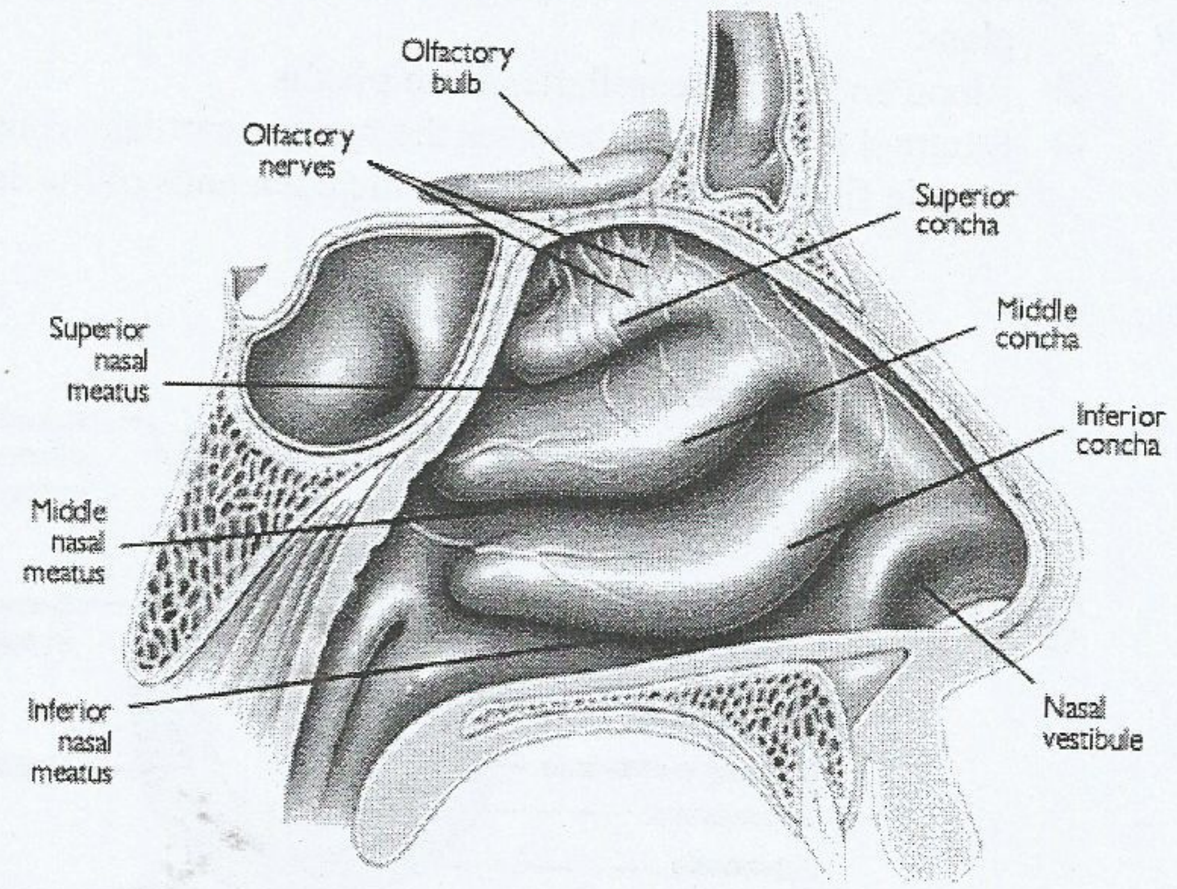
- ciliated pseudostratified columnar epithelium with numerous Goblet cells.



- Deeper in the bronchial tree this epithelium undergoes a transition to simple columnar, which is further reduced to simple cuboidal and simple squamous epithelium at the respiratory portion.
The typical respiratory epithelium has three cells types as seen in light microscope :
  - Ciliated Columnar – Goblet- Basal cells

NASAL CAVITY:

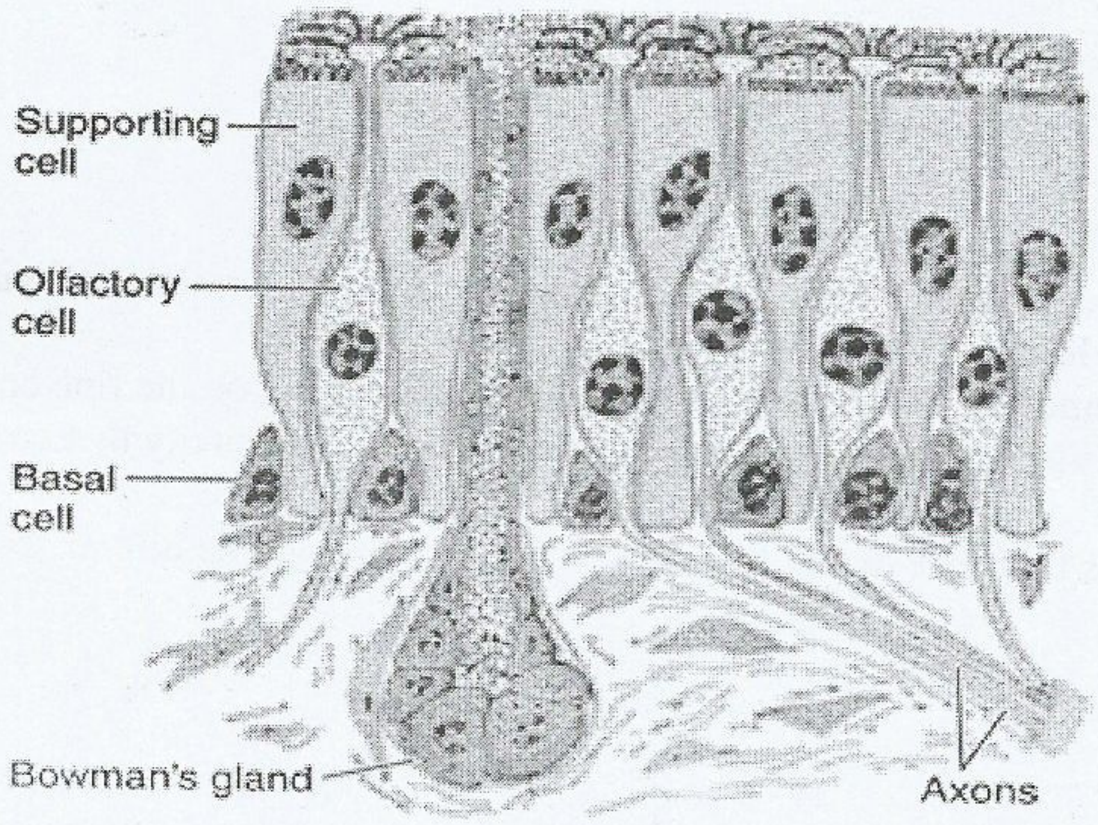
- Each nasal cavity is divided into The vestibule and nasal fossae and paranasal sinuses
- The vestibule is the most anterior and dilated portion of the nasal cavity.
- The skin over the external surface of the nose enters into the anterior part of the vestibule.
- It contains sweat and sebaceous glands and hair follicles with thick short hairs (Vibrissae).
- Within the vestibule, the epithelium loses its keratinized nature and undergoes a transition into typical respiratory epithelium



Nasal fossae:

- They are within the skull separated by the osseous nasal septum .
- Extending from each lateral wall are 3 bony shelf like projections known as conchae.
- The middle and inferior conchae are covered by respiratory epithelium.
- The superior concha is covered by olfactory epithelium.
- Within the lamina propria of the conchae are large venous plexus known as swell bodies.
- Allergic reactions can cause abnormal engorgement of swell bodies and result is severely restricted air flow.
- In addition the nasal cavity has a rich vascular system; as a result the incoming air is efficiently warmed.
- The paranasal sinuses are cavities in the frontal, maxillary ethmoid and sphenoid bones, They are lined with a thin respiratory epithelium, The lamina propia is continuous with the underlying periosteum and contains a few small mucous glands . The mucus produced in these cavities drains into nasal passages through small openings as a result of the activity of its ciliated epithelial cells.

Sinusitis is an inflammatory process of the sinus mucosa mainly because obstruction of drainage orifices

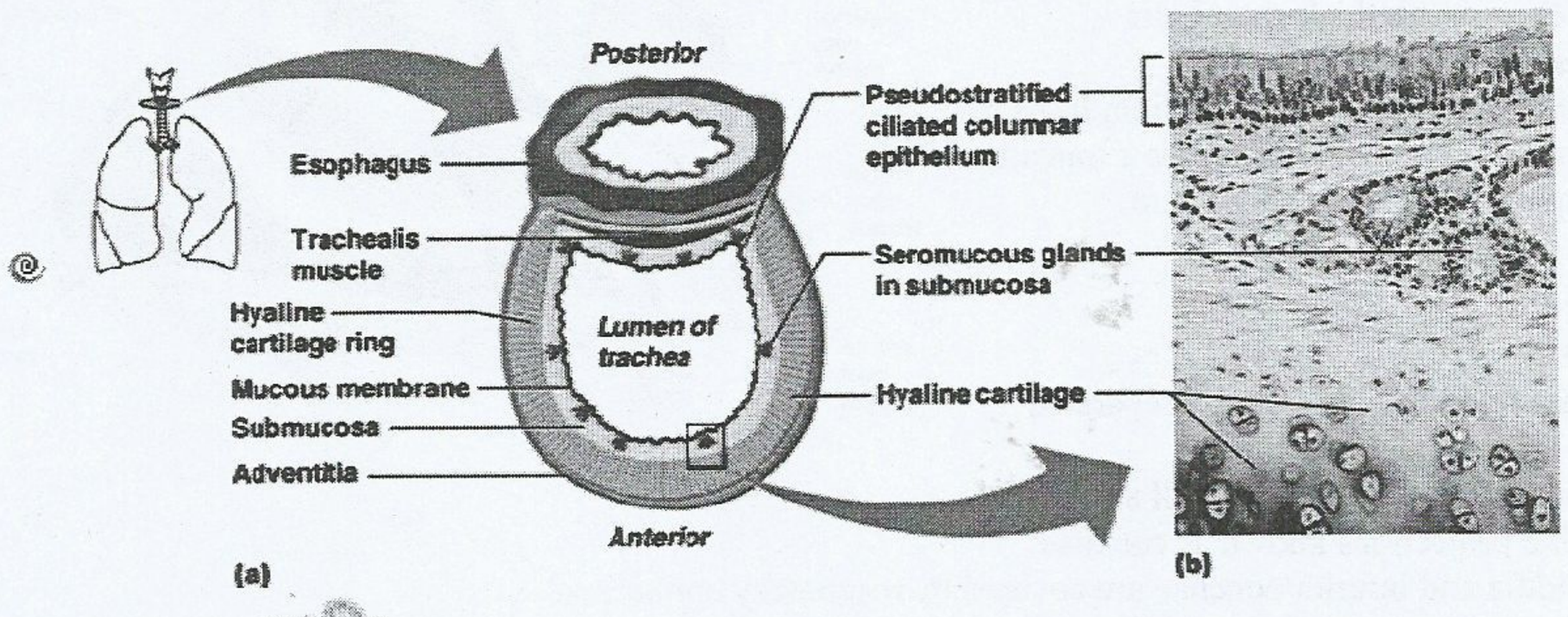


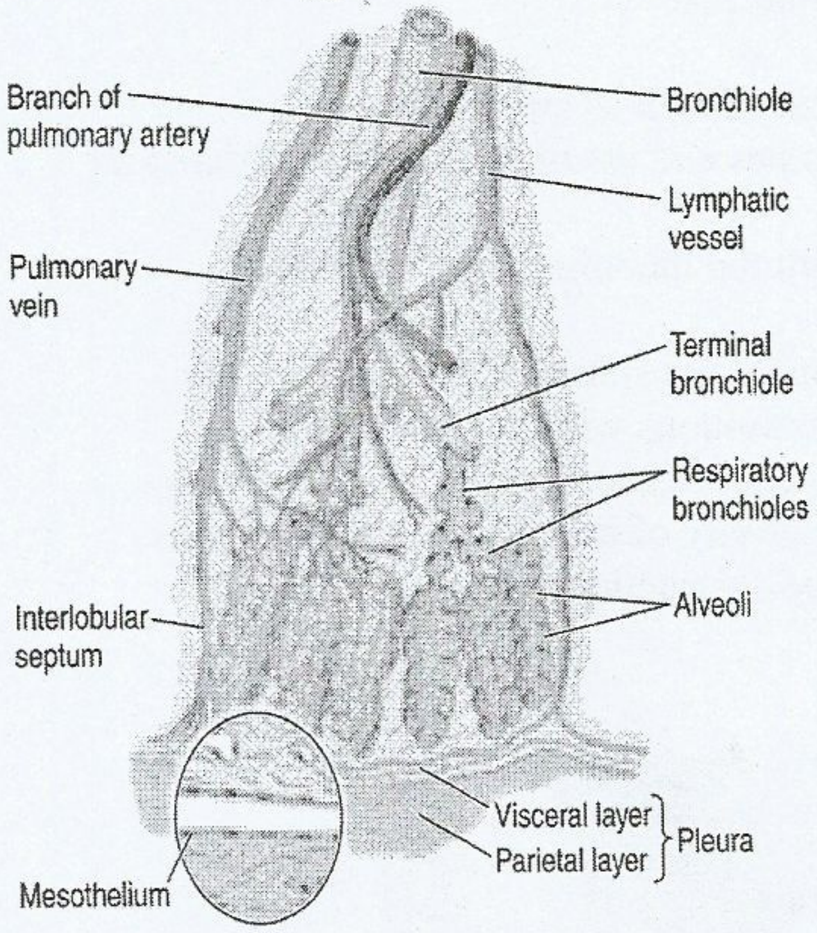
OLFACTORY MUCOSA

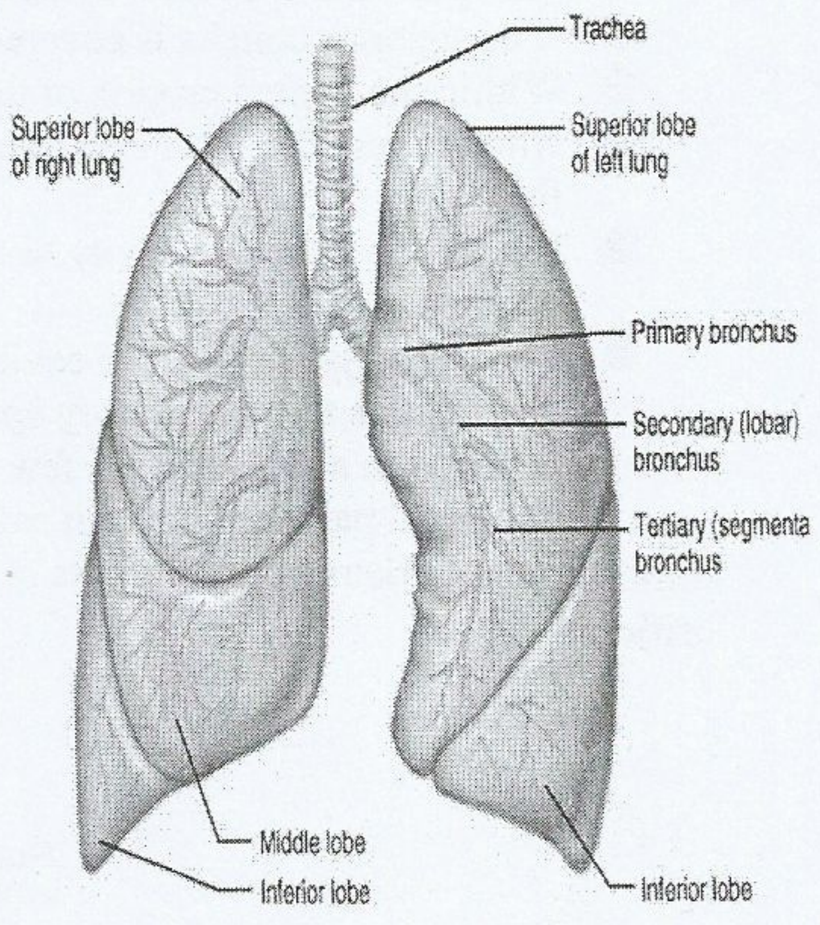
TRACHEA AND LUNG

trachea is a tube about 10 cm long, that extends from the larynx to the point at which it bifurcates into 2 primary bronchi.

- Lining the trachea is mucous membrane with a typical respiratory epithelium resting on a basal Lamina and supported by a lamina propria where lymphocytes are common.
- There are many elastic fibers that forms an indefinite layer at the junction with the Submucosa
- The Submucosa of loose areolar fibroconnective tissue presents many mixed glands and some serous gland
- Blood and lymph capillaries form plexus
- External to the Submucosa are the hyaline cartilage rings(C-shape).the trachialis muscle(smooth muscle fibers) extended between the open ends of the cartilage





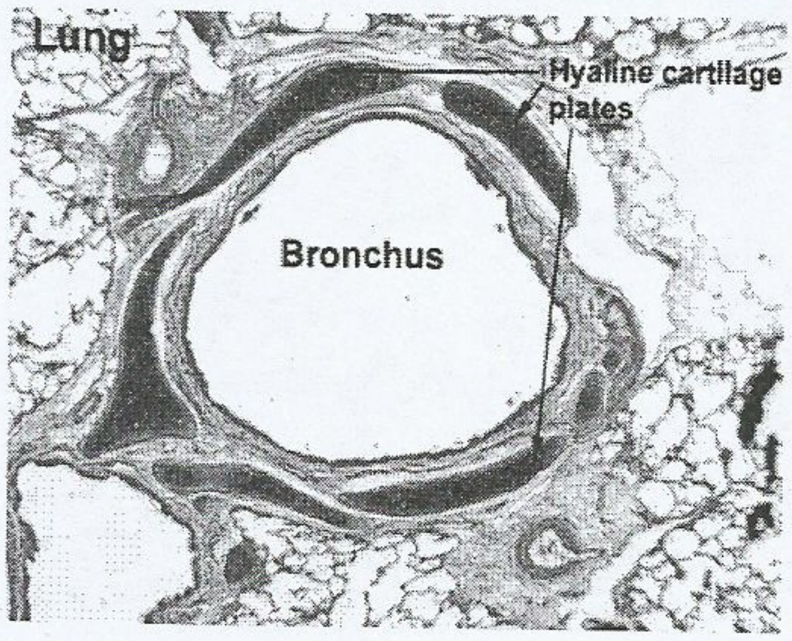


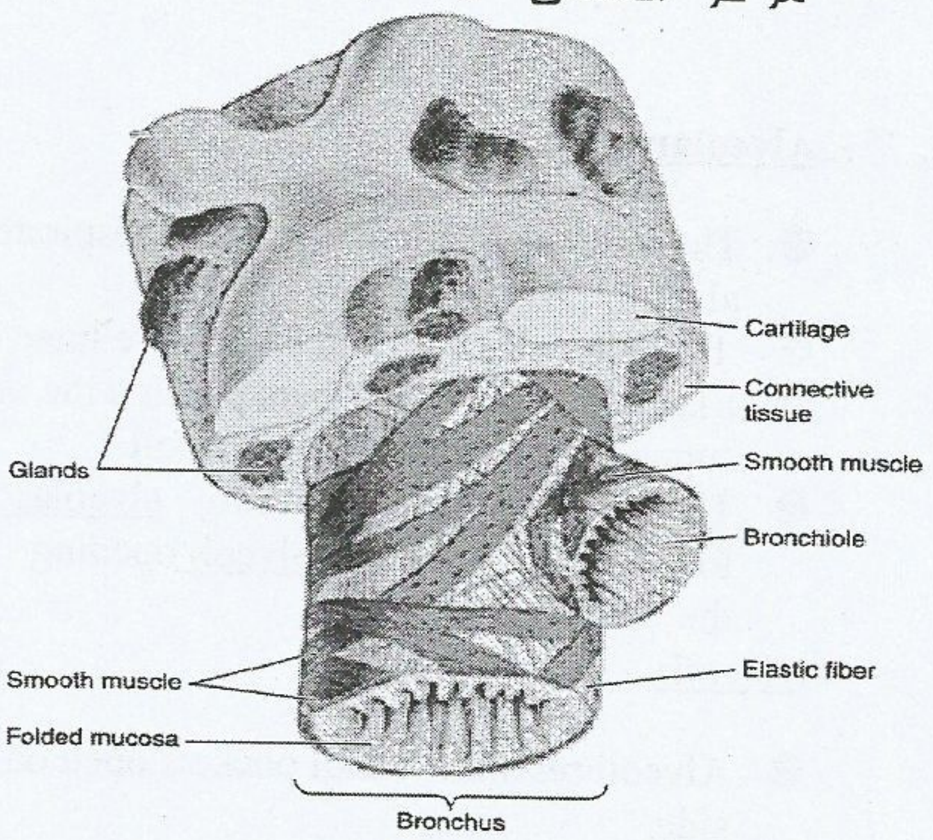
Lung:

- The lung is covered by Pleura , which consists of 2 layers, parietal and visceral while are continuous the region of the hilum.
- Both membranes are composed of mesothelial cells resting on the fine connective tissue layer.
- Between the visceral and parietal pleura there is the pleura cavity that contains a small amount of watery serous fluid.
- All structures that goes to and from the lung do so through the hilum,

Intrapulmonary bronchi (Secondary bronchi)

- Mucosa: is highly folded with pseudostratified ciliated columnar with goblet cells rest on C.T there is no submucosa.
- Muscle layer: consists of a spiral layer of smooth muscle fibers.
- Supporting layer: containing several irregular cartilage plate or rings completely encircle the lumen





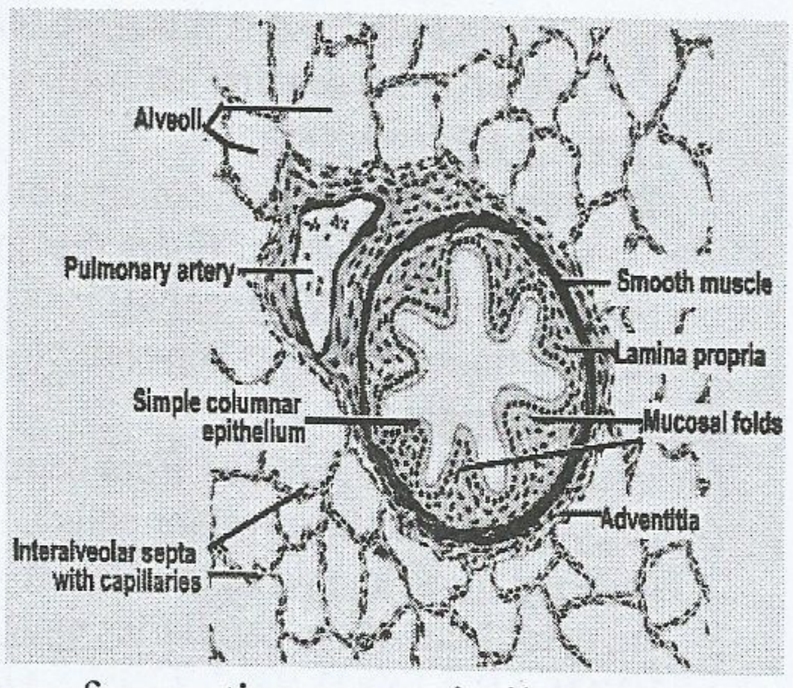
Bronchioles:

usually are 1 mm in diameter or less.

The mucosa is lined by simple ciliated columnar epithelium no goblet cells. the muscle is circular smooth muscle fibers.

bronchioles have neither glands nor cartilage

At the terminal bronchioles there are of ciliated cuboidal cells.

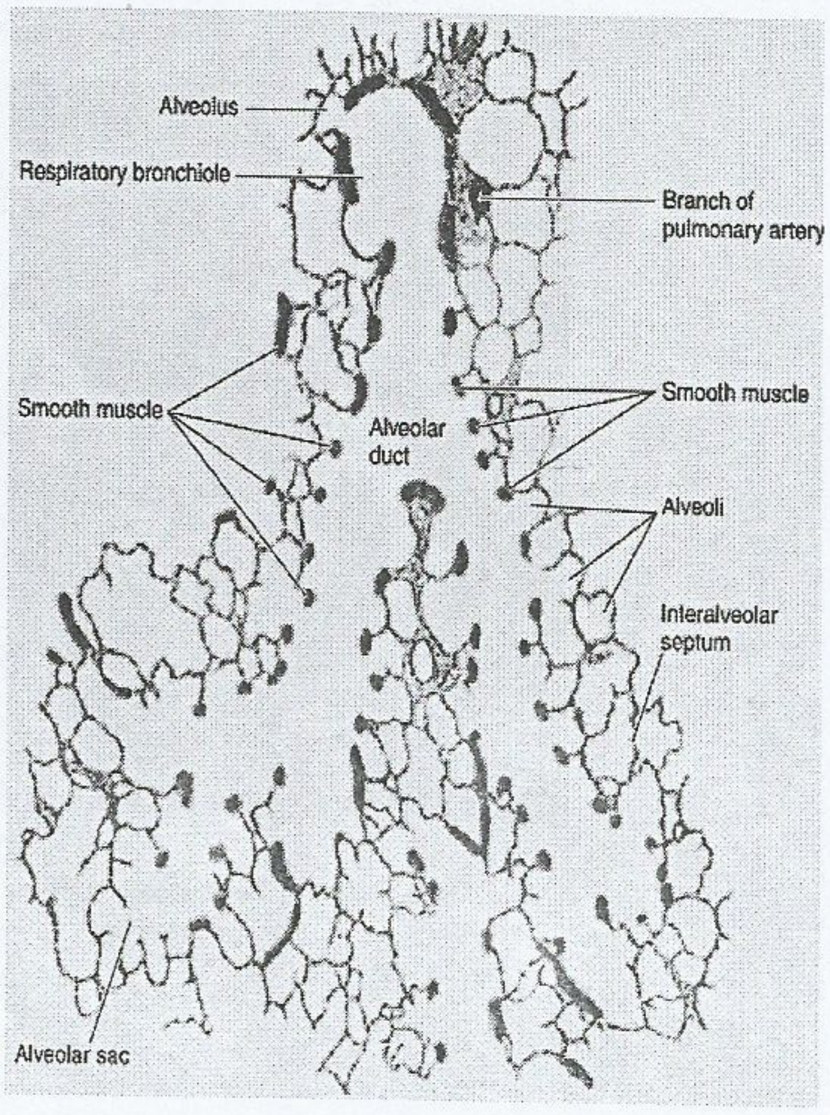


- Scattered between them are Clara cells nonciliated cells.
- Clara cells appear to be secretory cells probably they produce surface-active agent similar to the surfactant present in alveoli.
- The lamina propria is similar to that of the bronchioles.
- Increase airway resistance in asthma Is believed to be due mainly contraction of bronchiolar smooth muscle

RESPIRATORY PORTION:

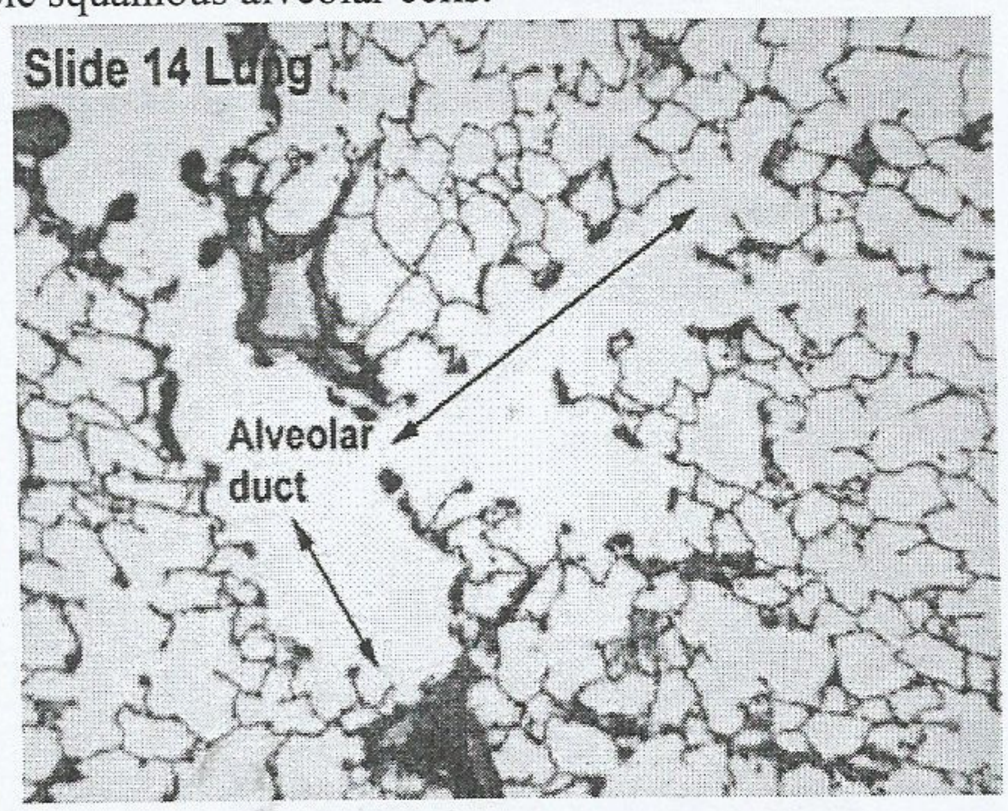
Respiratory bronchioles;

- Each terminal bronchiole subdivides into 2 or more respiratory bronchioles'
- Its mucosa is structurally similar to that of the terminal bronchioles except that their walls are interrupted by many alveoli where gases exchange occurs
- Distally along this bronchioles the distance between the alveoli is reduced, thus the number of alveoli increase,
- and the epithelium between alveoli consist of low cuboidal non ciliated cells
- Smooth muscle and elastic connective tissue lie beneath the epithelium.



Alveolar ducts:

- They are the continuation of the respiratory bronchioles . Their walls consists of closely spaces alveoli.
- Both alveolar duct and alveoli are lined by simple squamous alveolar cells.
- Elastic and collagen fibers provide the only support of the duct and its alveoli.
- The alveoli ducts open into alveolar sacs formed by numerous alveoli opening into the same atrium



Alveoli:

- Alveoli resemble small pockets open on one side.
- Within this cuplike structures oxygen and CO-, are exchanged between the air and the blood.
- Generally, between 2 neighboring alveoli is a common wall and is therefore termed an Interalveolar septum or wall.

Interalveolar septum

- Interalveolar septum consists of 2 thin squamous epithelial layers between which lie a framework of elastic and reticular fibers that gives support to capillaries, fibroblasts, smooth muscles fibers and macrophages (dust cells)
- the thinnest barrier between blood and inspired air is reduced to the blood-air barrier

Blood-air barrier:

Air in the alveoli is separated from capillary blood by 3 components:

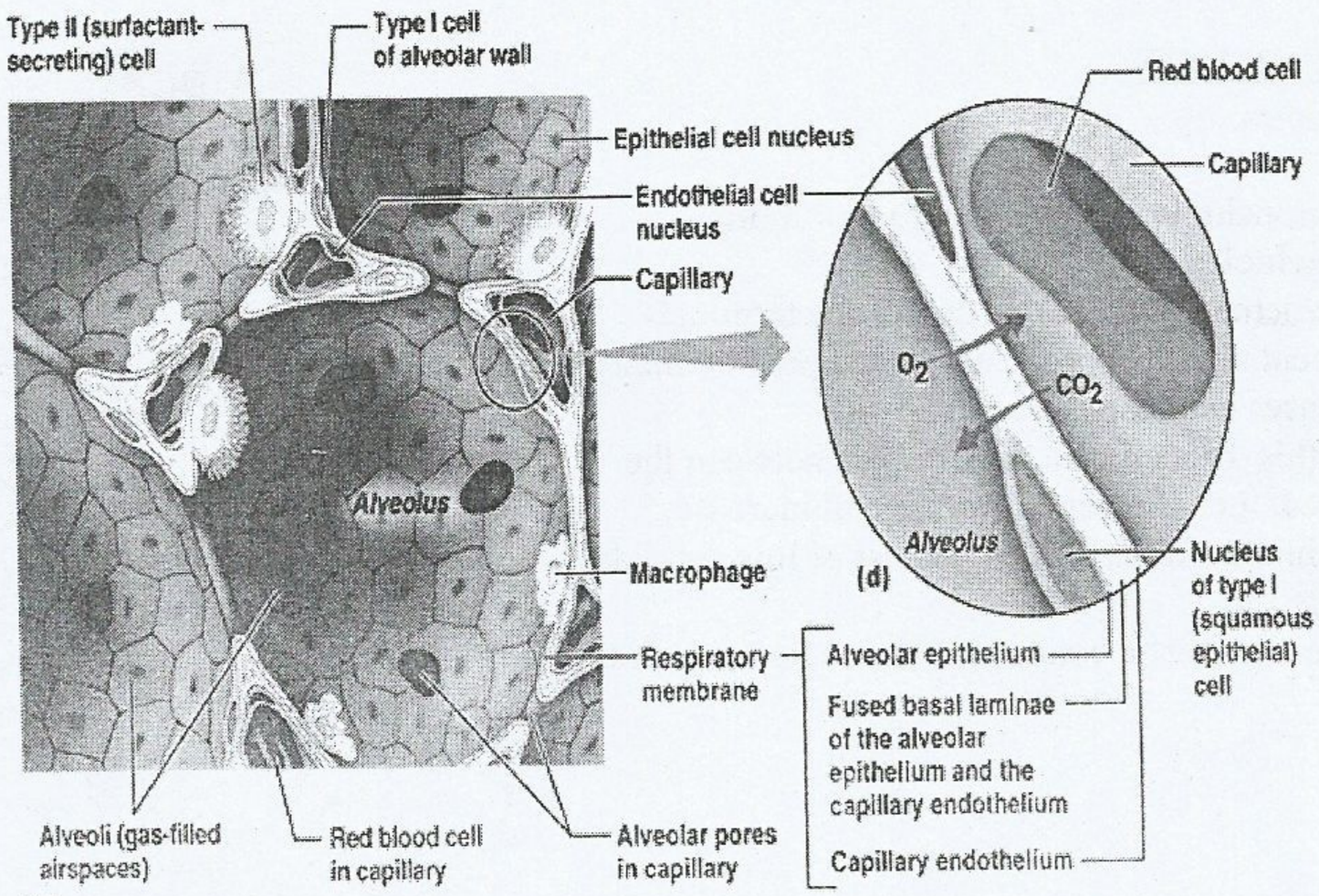
1-The cytoplasm of the alveolar cells I,

2-The fused basal lamina of the closely opposed alveolar and endothelial cells,

3- The cytoplasm of the capillaries endothelial cells.

ALVEOLAR LINED BY 2 TYPES OF CELLSAlveolar Cells: There are two main types of alveolar cells;

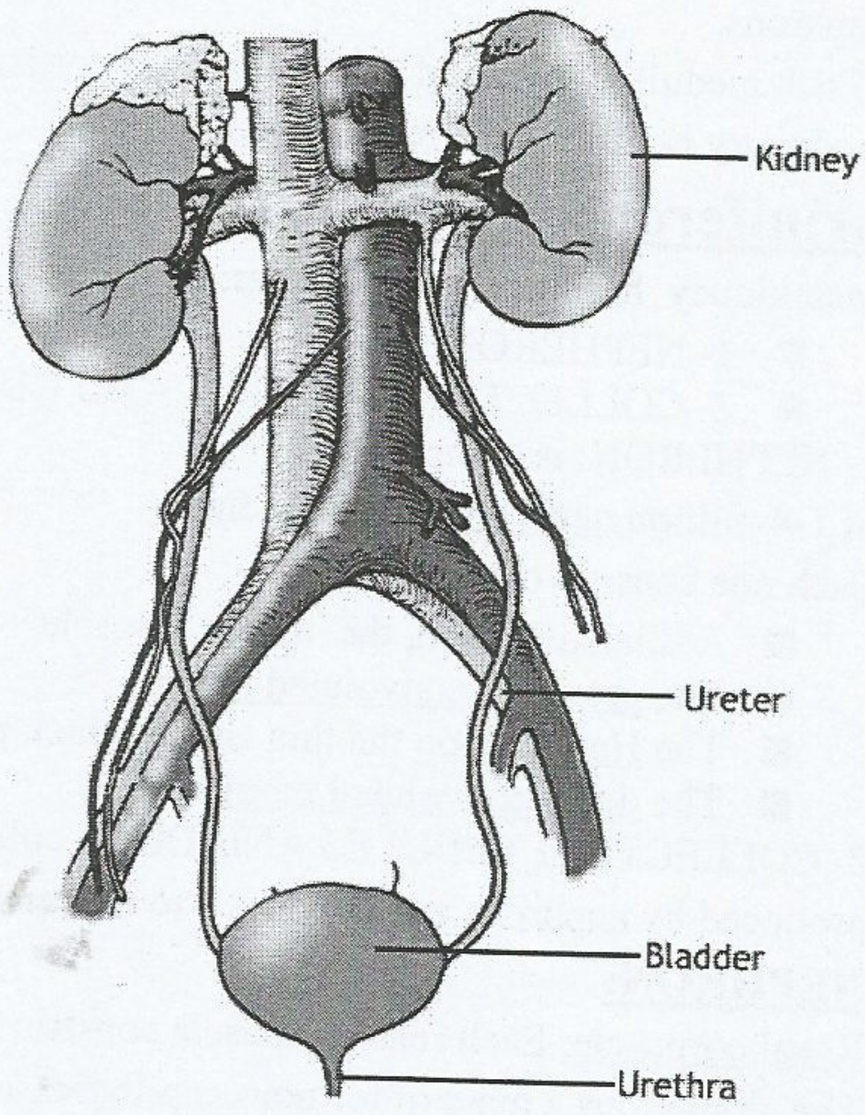
- **Type I :**called squamous alveolar cells make up to 95% of the "alveolar Surfaces".
- Are very thin cells , The main role these cells is to provide a barrier that is readily permeable to gases.
- **Type II or septal cells** are found among the type 1 alveolar cells. Are cuboidal cells.
- Secrete pulmonary surfactant: (pulmonary surfactant) that lower alveolar surface tension.



THE URINARY SYSTEM

consists of :

1. kidneys
2. Two ureters
3. Bladder
4. Urethra.



FUNCTIONS OF THE URINARY SYSTEM :

- producing urine in which metabolic waste products are eliminated.
- The kidneys also regulates the water and electrolyte balance of the body.

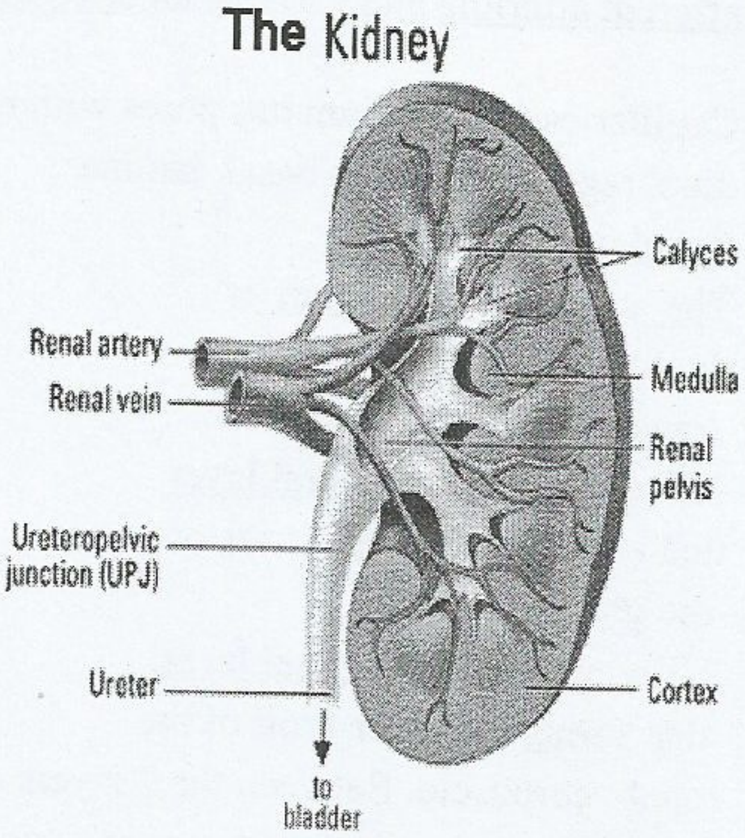
- They are the site of production of two hormones:

1. Renin related to the blood pressure

2. Erythropoietin related to the red blood cells formation

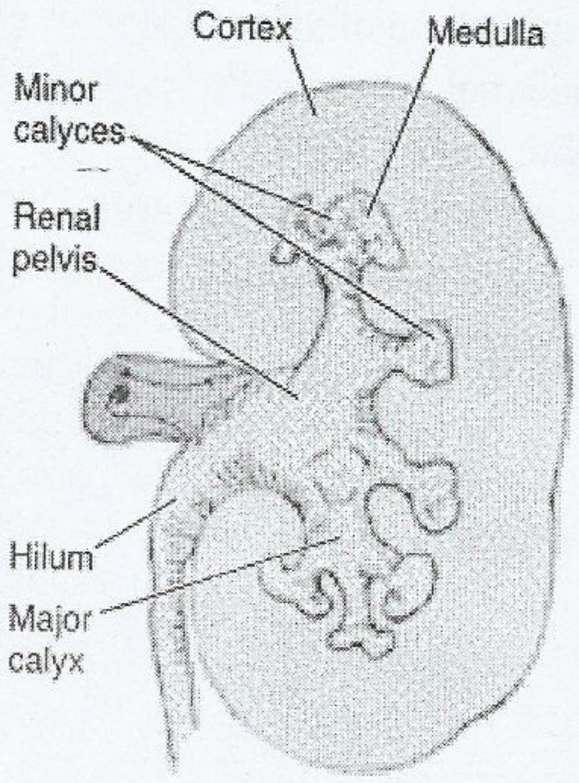
Blood At Kidneys

The filtration of the blood at the kidneys forms the filtrate (similar to blood plasma)
then by selective absorption at the kidney tubules most of the filtrate is reabsorbed but waste products (such as urea and creatinine) are secreted in the urine.
In man the total filtrate is 170-200 liters in 24 hours, of this, some 99% will be reabsorbed
The parenchyma of the kidney can be divided into an outergranular cortex owing to the presence of spherical renal corpuscles and convoluted tubules and an innerstriated medulla due to the presence of straight tubules and blood vessels.

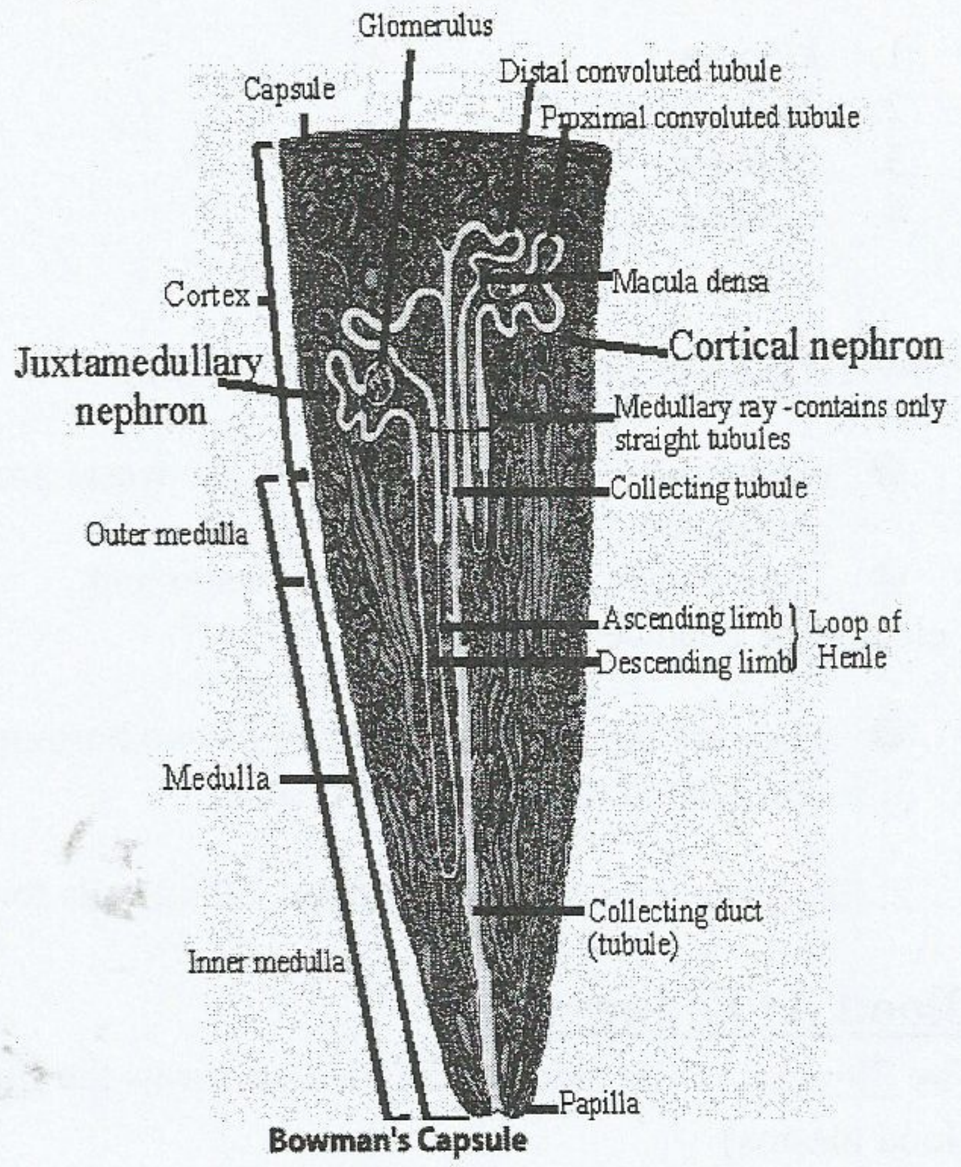


KIDNEY:
- A kidney resembles a bean with a concave medial border.
- Its stroma is a thin fibroconnective tissue capsule surrounded by some adipose tissue. No septa are present within the kidney; at the concave medial border there is the hilium; where nerves and blood vessels enter and exit, and the ureter-the excretory duct- leaves the kidney.

THE URETER:
The expanded upper end of the ureter is called the renal pelvis, which is divided into 2-3 major calyces Several smaller branches the minor calyces arise from each major calyx.
In humans the renal medulla has 10-18 conical structures, the medullary or renal pyramids , whose base from the cortico- medullary junction and whose apex, called renal papillae, protrude into the minor calyces and are perforated by 10-25 orifices.
Between medullary pyramids is cortical tissue, termed columns of Bertin.
- From the base of each medullary pyramid the medullary rays penetrate the cortex.



- Each medullary ray consists of one or more collecting tubules, together with the straight portions of several nephrons.
- Each medullary pyramid and the mass of cortical tissue over the pyramid forms a renal lobe, and each medullary ray forms the renal lobule.



uriniferous tubules

each kidney has uriniferous tubules:

- 1- NEPHERON
- 2- COLLECTING TUBULES AND DUCT

1- NEPHERON: is composed of 1-4 million nephrons in each kidney

Each one consists of:

- A dilated portion, the renal corpuscle
- The proximal convoluted tubule.
- The Henle's loop the thin and the thick portions and
- The distal convoluted tubule.

2- COLLECTING TUBULES AND DUCT collect the urine produced by nephrons and conduct it to the renal pelvis

NEPHRON:

Renal corpuscle: Each renal corpuscle consists of:

The glomerulus a mass of tortuous capillaries arise from afferent arteriole and leave as an efferent arteriole. The

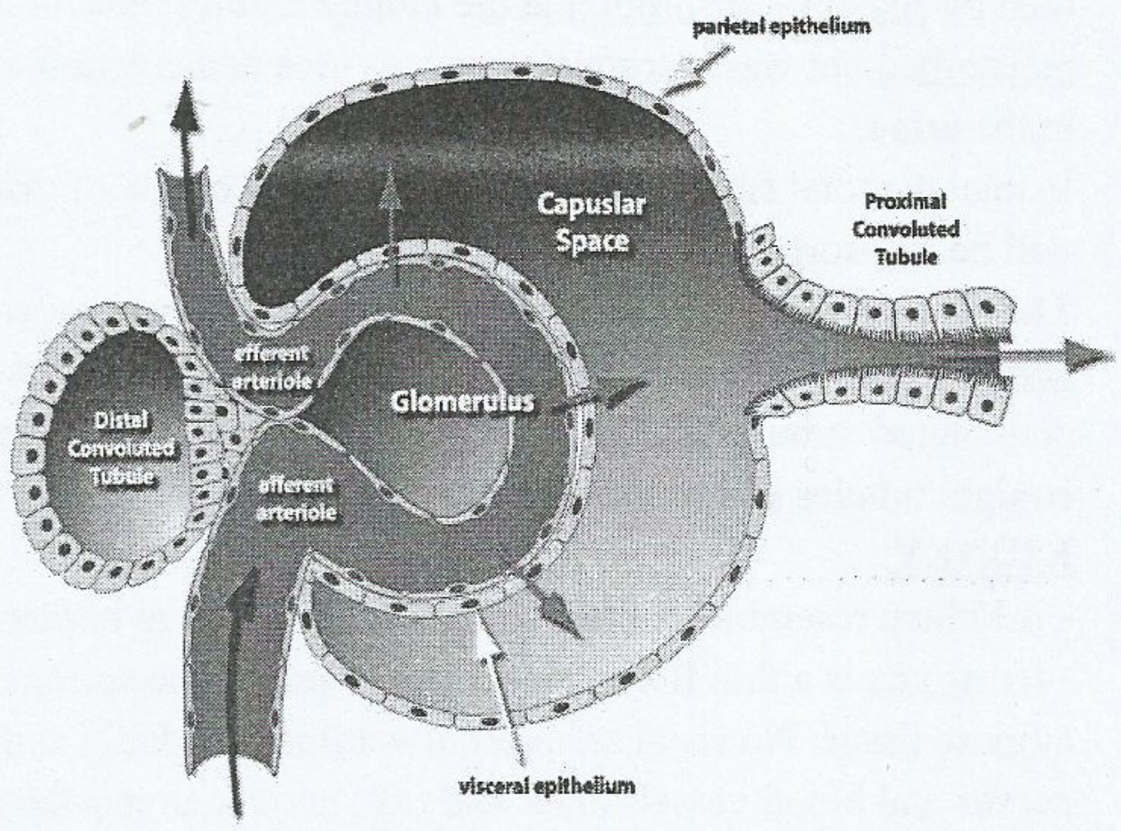
Capillaries endothelium has pores with no diaphragms with thick basal lamina.

Renal corpuscle

The capsule of Bowman is double-walled cup –shape structure with:

1.The internal or visceral layer that envelops the capillaries of the glomerulus.

2.The external or parietal layer, that forms the outer limit of the renal corpuscle. Between the 2 layers of capsule is the urinary Bowman space or capsular space which receives the fluid filtered through the capillary wall and the visceral layer.



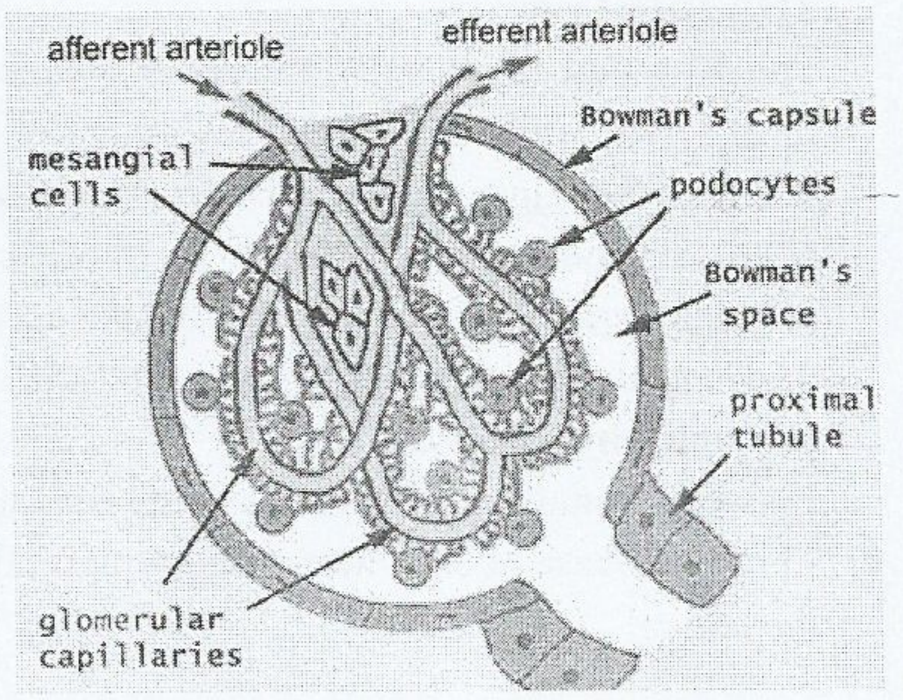
The epithelium of visceral layer is greatly modified. The cells of this internal layer, the Podocytes satellite shaped have:

The cell body from which arise several

1) major or primary process that embrace the capillaries of the glomerulus and finally
2) each primary process gives rise to numerous secondary process called pedicels, that are attached to

outer surface of a thick basal lamina which is formed by both capillary endothelial cells and podocytes. The secondary process of podocytes interdigitate,

The parietal layer of Bowman capsule consists simple squamous



epithelium, supported by a basal lamina and a thin layer of reticular fibers.

At the urinary pole the epithelium changes to simplecolumnar epithelium at the proximal tubule Between capillary loops are areas not lined by podocytes, there are mesangial cells, their processes penetrate between the endothelial cells and their basal lamina.

Mesangial cells synthesize the amorphous matrix that surrounds them and contribute to the support of the capillary wall; they are pericyte-like cells, have phagocytic activity and can contract when stimulated.

The proximal and distal convoluted tubules are cut in various directions and can be differentiated from each other in the following way:

1) The cytoplasm of the proximal is more acidophilic than that of the distal.
2) Cell boundaries are distinct in the distal while in the proximal they are not.
3) In cross section the number of nuclei are 4 or 5 in the proximal and up to 8 in the distal.
4) The cells posses a clear brush border in the proximal whereas no distinct brush border is found in the distal.
5) The number of segments of the proximal tubule exceeds that of the distal.
6) The cells are higher and wider and therefore the lumen is narrower in the proximal than in the distal.

The Cells of the (D.C.T.) become columnar in the Juxtaglomerular region, and their nuclei are closely packed together For this reason appears darker in microscopic preparations and is called the **Macula Densa**.

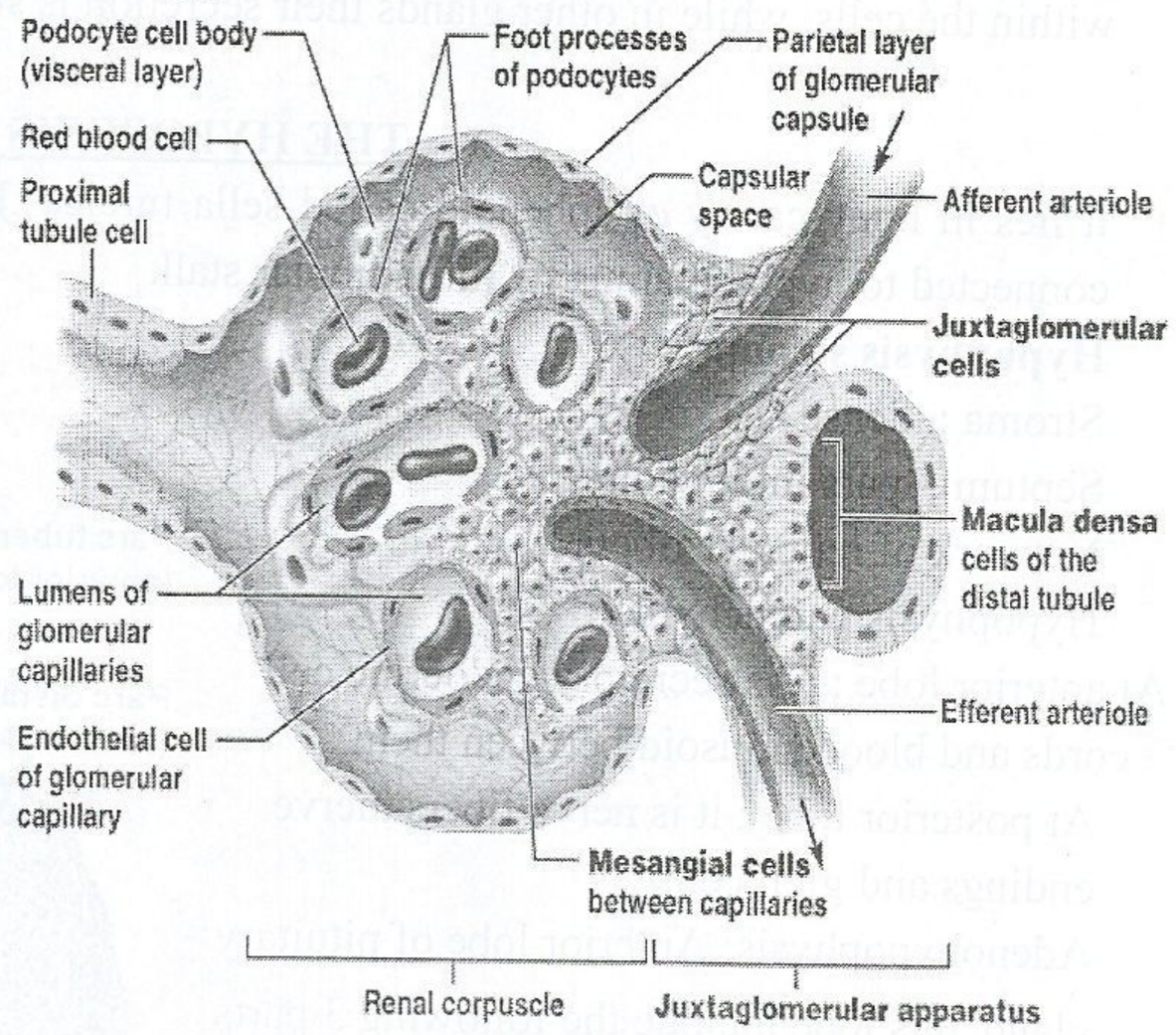
- The functional significance of the macula densa , it may be a sensor of the osmolarity of the fluid in the distal tubule.
- The urine passes from the distal convoluted tubules to collecting tubules, which widen gradually as they approach the tips of the pyramids.
- The smaller collecting tubules are lined with cuboidal epithelium
- As they penetrate deeper into the medulla their cells become taller cuboidal until they are columnar cells.
- present short microvilli
- Collecting tubules and ducts cells stain weakly, Cortical collecting ducts are joined by several smaller collecting tubules draining each medullary ray.
- collecting ducts are a major component of the urine concentration mechanism

Juxtaglomerular complex

1-Juxtaglomerular (J.G.) cells Near the renal corpuscle, the tunica media of the afferent arteriole presents modified smooth muscle cells, with epithelioid character.

2-The macula densa of the distal convoluted tubule is in close relation to the J.G.

3- Extraglomerular mesangial cells or Lacis, also called pole cushions.



ENDOCRINE SYSTEM

The body functions are controlled by :

1-Nerves system 2-Endocrine system

The endocrine system is composed of ductless glands whose secretions- hormone-are passed directly into the blood or lymph circulation.

both of these systems are integrated and coordinated by hypothalamus

The endocrine components occur in 3 forms:

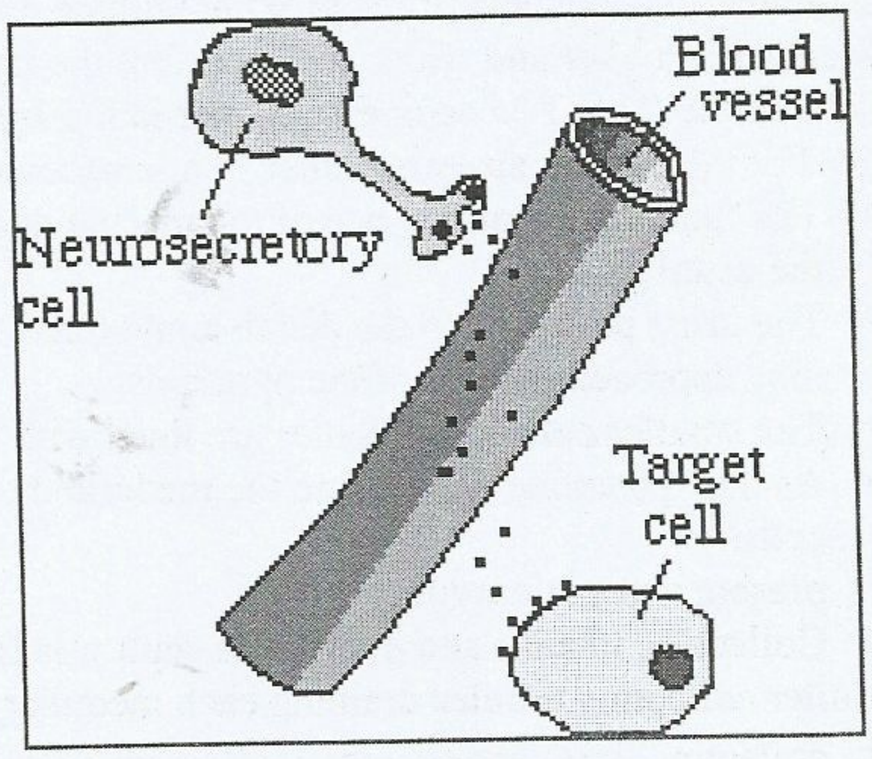
1-As separate entities such as; pituitary, thyroid, parathyroid, and suprarenal glands .

2- As isolated endocrine cells (APUD), present within lining epithelium of gastrointestinal and respiratory tracts.

3- As scattered masses of endocrine tissue within exocrine glands or other gland as mixed gland such as; pancreatic islets, Interstitial - Leydig's cells of testis and corpora lutea of ovary.

Neuroendocrine system:

Overlapping mechanism in which many biological activities are under control of both nerves and endocrine systems.



General structure :

As compact organ, endocrine glands present;

1- the stroma formed by ;

a- capsule b- septa c-reticular network

2-the parenchyma formed by the secreting cells grouped in cords and clumps with many capillaries or sinusoids between them.

In most of the endocrine glands their secretion is stored within the cells, while in other glands their secretion is stored in central mass.

THE HYPOPHSIS GLAND

It lies in bony cavity of sphenoid called sella turcica .Pituitary gland weighs only about 0.5g It is connected to hypothalamus by infundibular stalk

Hypophysis stroma :

Stroma ; dense C.T .

Septum ; pars intermedia .

Network of reticular fibers .

Hypophysis parenchyma :

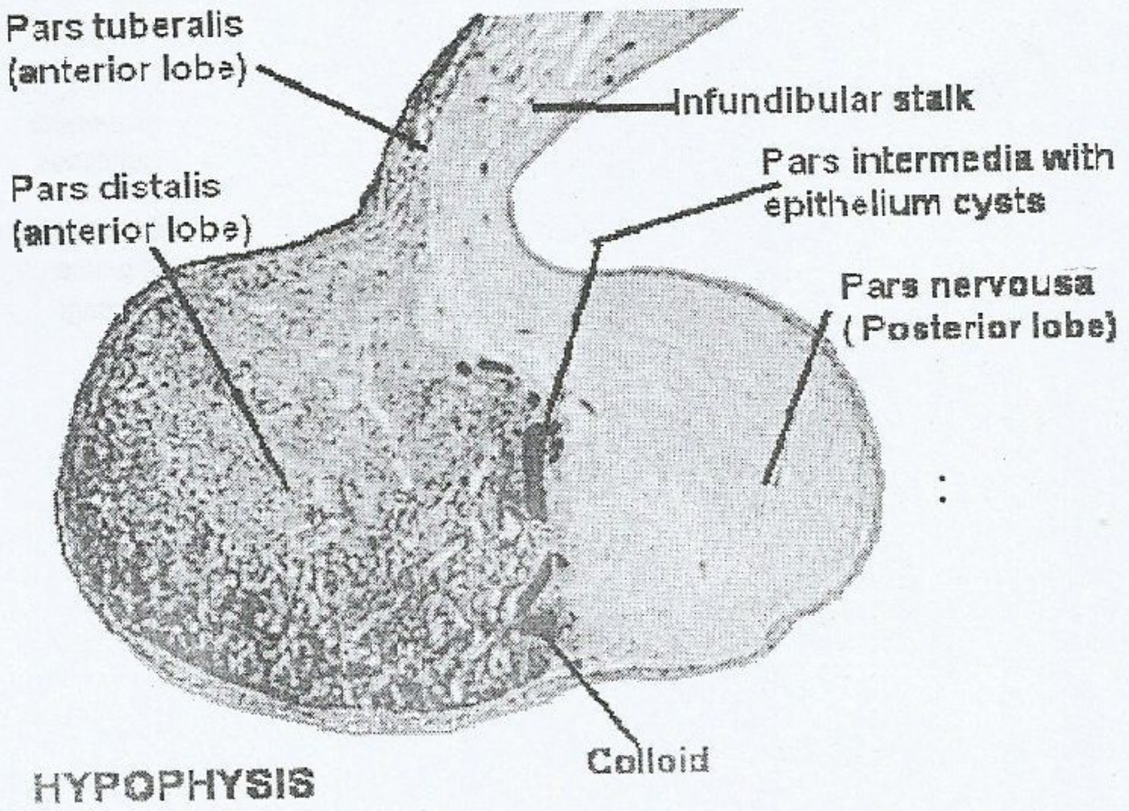
At anterior lobe ; it is secretory endocrine cell cords and blood sinusoid between them .

At posterior lobe ; it is nerve fibers ,nerve endings and glial cells .

Adenohypophysis: Anterior lobe of pituitary gland, this lobe include the following 3 parts

1-Pars Distalis

2-Pars Tuberalis



HYPOPHYSIS Gland

3-Pars Intermedia.

1- Pars distalis:

Larger part it makes upto75 % of pituitary gland.

It's parenchyma composed secretory cells arranged as cords, many capillary and fibroblasts, which secretes the reticular fibers network that supports the cell cords and attached to capsule.

According to staining characteristics there are 2 main types of epithelial cells in the pars distalis :

1- Chromophobes cell 2- Chromophils cell

1-Chromophobes cells :

They also called Chief or C cells.

They make up to 52 % of cells of pars distalis .

They dislike histological stains so called chromophobe cell.

They are small and round , they secrete very few hormones so show no visible secretory granules.

They maybe form chromophils cells, they may be resting or reserve cell

2- Chromophils cells :

They constitute about 48 percent

According to the affinity with which their specific granules take up acidic or basic stains, chromophil cells are subdivided into :

a- Acidophil cells b- Basophil cells

they have numerous membrane-limited granules containing the hormonal secretory product .

A- Acidophils or alpha cells:

They larger than chromophobes and have eosinophil granules within their cytoplasm .

According to hormone secreted can be classified in:

1. Somatotropic cell 2.Lactogenic hormone cell

1. Somatotropic cells:

They secret growth or somatotropin hormone .

Target organ : skeletal system

An excess of its secretion in children produces gigantism. While in adults it produces acromegaly.

Deficient secretion of STH during childhood causes hypopituitary dwarfism as incomplete growth of long bones.

2.Lactogenic hormone cells:

These cells also called Mammotroph cells

They secrete lactogenic hormone-prolactin, luteotropic hormone or LTH, Which initiate and maintains milk secretion after pregnancy The role of this hormone in males isn't clear.

B- Basophils or beta cells :

These cells are larger than acidophils.

They contain basophilic granules and this are less numerous than in acidophils.

According to hormone secreted these cells can be classified into

1.Gonadotropic cells :

They are larger than other cells of adenohypophysis

There are 2 subtypes of Basophil Gonadotrophic cells:

a-Follicle stimulating hormone secreting cells :

These cells secrete follicle stimulating hormone (FSH) which stimulates follicular development in ovary and spermatogenesis in testes .

b-Luteinizing hormone secreting cells :

In female they secrete luteinizing hormone
(LH) which responsible for final maturation of the follicles ,also for development of corpus luteum and secretion of progesterone by corpus luteum .
In male they secrete interstitial cells stimulating hormone –ICSH- which stimulate testosterone secretion by interstitial cells .

2.Thyrotropic cells :.

Their cytoplasm rich in small basophilic granules .
They produce Thyroid Stimulating Hormone –TSH- also called Thyrotrophine Hormone that stimulates the synthesis and liberation of the thyroid hormone .
Their secretion is regulated by thyrotropin releasing hormone from hypothalamus

3.Coticotropic cells:

They secrete Adrenocorticotrophic Hormone(ACTH) which promotes growth of suprarenal cortex and stimulate secretion of Glucocorticoids and adrenal androgens by zona fasciculata and zona reticularis of cortex, also stimulate secretion of aldosterone.

Pars tuberalis ;

It's a funnel shaped region which surrounds the infundibulum of neurohypophysis.
Its highly vascularized

Pars tuberalis ;

It's a funnel shaped region which surrounds the infundibulum of neurohypophysis.Its highly vascularized

NEUROHYPOPHYSIS

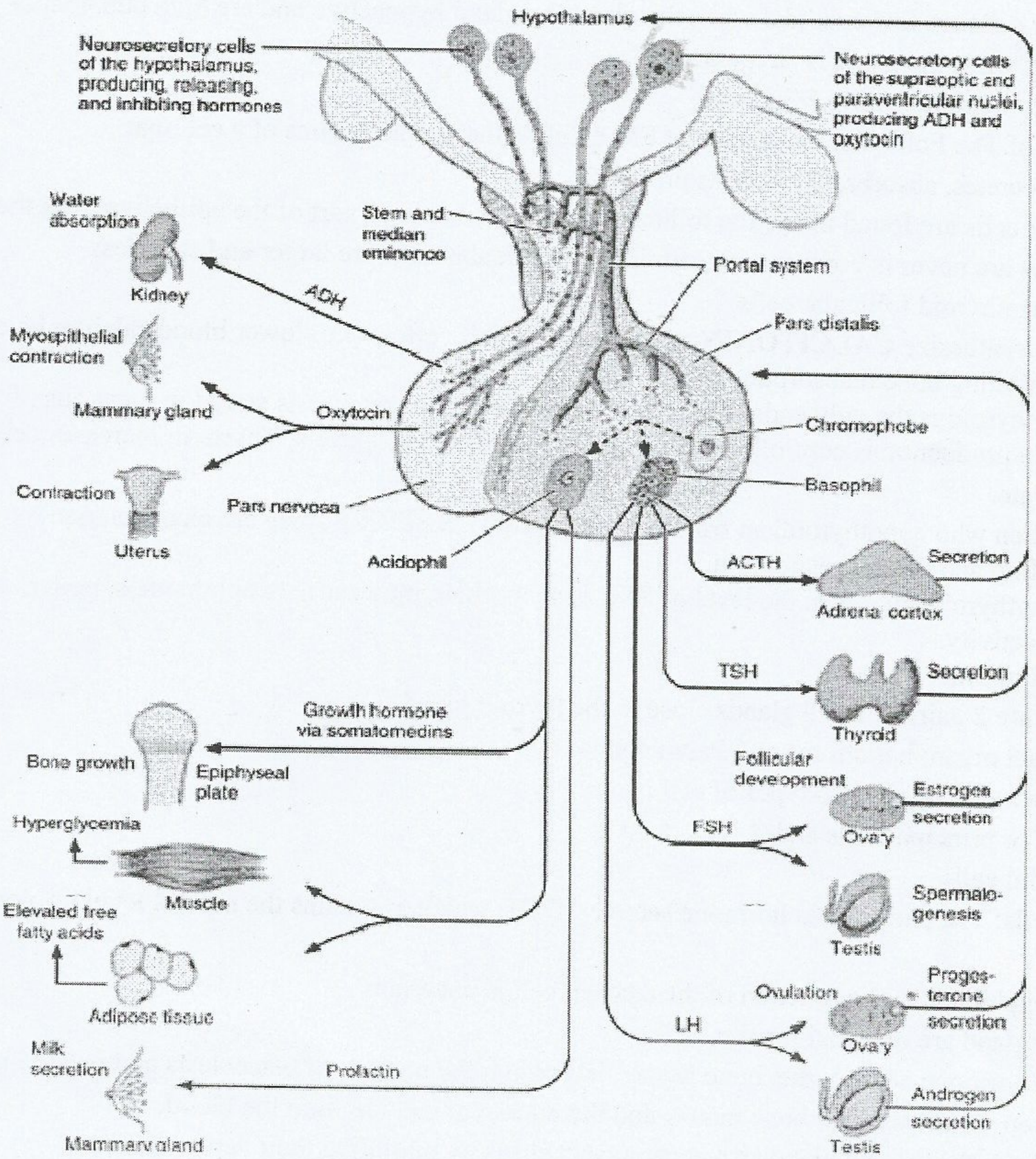
POSTERIOR LOBE OF PITUITARY GLAND

The neurohypophysis includes:

1.Pars nervosa 2.Infundibulum stem 3.Median eminence

All three portions have the same characteristic cells, the same nerve and blood supply and contain the same active hormonal principle.
Unlike adenohypophysis there are about 100,000 unmyelinated axons of neurosecretory cells pass through infundibulum stem to end in pars nervosa, their cell bodies are found within the supraoptic and paraventricular nuclei of hypothalamus.
The cells of neurohypophysis, pituicytes, resemble neuroglial cells of S.N.S. It's function like supporting neuroglia of S.N.S.
The neurons of supraoptic and paraventricular nuclei are typical neurons also they are neurosecretory which elaborate material that passes along the unmyelinated nerve fibers of the neurosecretory cells that form the hypothalamus–hypophyseal tract to termination of fibers in the pars nervosa where the secretion is stored .
By L/M the neurosecretory granules visible as Herring bodies
The neurosecretory mater consists of two hormone ; oxytocin and vasopressin, which are released from hypothalamus and stored at Herring bodies and released into blood by impulses in the nerve fibers.
-The fibers from supraoptic nuclei are mainly concerned with vasopressin or anti-diuretic hormone ,while those axon from paraventricular nuclei are concerned with oxytocin secretion .

-Vasopressin also called anti diuretic hormone (ADH), promotes the contraction of smooth muscle cells of blood vessels, increasing the blood pressure.
-The main effect of ADH is increase the permeability to water of collecting tubules of the kidney.
-Lesions of the hypothalamus cause diabetes insipidus a disease characterized by loss of renal capacity to concentrate urine. A person suffering from this disease will drink large amount of liquids and may excrete up to 10-20 liters of urine per day (polyuria).
-Oxytocin stimulates contraction of smooth muscle cells of uterine wall during childbirth and contraction of myoepithelial cells that surround the alveoli of themammary glands.



The THYROID GLAND

The Thyroid gland, located anterior to the larynx consists of 2 lobes connected by a narrow isthmus.

It's function is to synthesize the hormones thyroxin and thyrocalcitonin

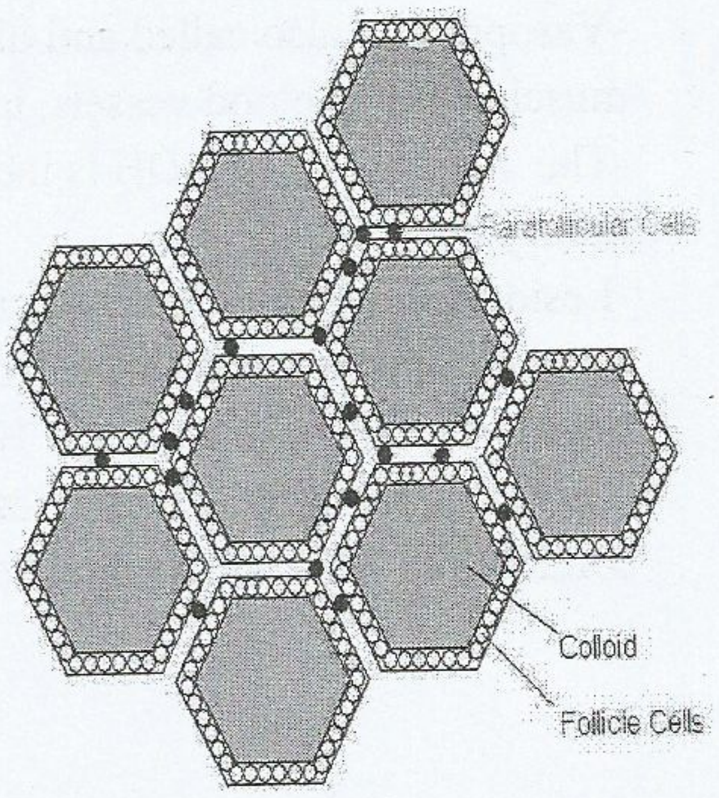
The stoma of the gland presents a C.T. capsule that sends septa into the parenchyma, forming lobes and lobules, and a fine irregular reticular fibers network

The parenchyma structural units are the follicles , that have:

1- A layer of simple epithelium, usually cuboidal, the follicular cells.

2-A cavity filled with colloid ; and

3- The Parafollicular cells or C cells found as part of the follicular epithelium or as isolated clusters between the follicles .



The thyroid epithelium rests on a basal Lamina.

The Follicular cells are low cuboidal when the gland the gland hypoactive and are high cuboidal or even columnar when the gland is "hyperactive".

The apical cell membrane have Microvilli

The structure of The Follicular epithelium at EM exhibits the characteristics of a cell that synthesizes, secretes, absorbs, and digests proteins.

Parafollicular cells are found inside the follicular basal membrane as part of the epithelium, but their apical surfaces are never in contact with colloid. Parafollicular cells are larger and stain less intensively thanthyroid follicular cells.

- They synthesize **CALCITONIN** an hormone which effect is to lower blood calcium levels by inhibiting bone reabsorption.
- The thyroid is the only endocrine, gland whose secretory product is stored in great quantity.

Thyroglubulin production is controlled by TSH from the adenohypbphysis, Thyroxin increases cell metabolism rate.

- Children who hypothyroidism from birth are called CRETINES; they are characterized by dwarfing and mental retardation.
- Hyperthyroidism; when the level of TSH is subnormal, may cause exophthalmos, goiter, and over activity.

Parathyroid glands:

parathyroid are 2 pairs of small glands close to the thyroid gland

As a compact organ: has stroma and Parenchyma

Parenchyma : consists of two types of cell :

1- The chief or principal cells and

2- the oxyphil cells

The chief cells: The parathyroid hormone secrete (PTH) which maintains the normal level of blood calcium.

And The oxyphil cells: The function of the oxyphil cell is uncertain.

Parathyroid gland are essential for life

Parathyroid hormone acts on the bone tissue , increasing the number of osteoclasts and promoting the absorption of the calcified bone matrix and the release of calcium into the blood.

Calcitonin from the thyroid gland also acts on osteoclasts by inhibiting their action on bone.

In hyperparathyroidism, blood calcium is increased. Bones are decalcified and become subject to fractures.

-Hypoparathyroidism causes an increase in the concentration of phosphate and a decrease in the concentration of calcium in the blood. Bones become more mineralized. This condition causes spastic contractions of the skeletal muscle, hyperexcitability and muscular spasms that lead to tetany and even death.

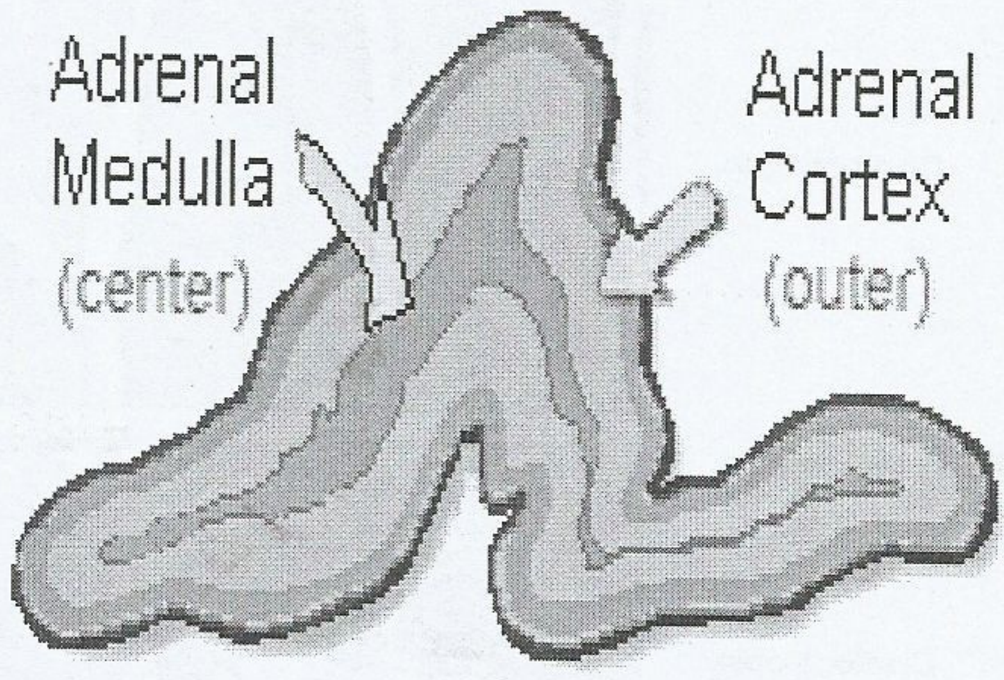
-The secretion of the parathyroid cell is regulated by the blood calcium level and not by other endocrine gland or nervous system.

THE SUPRARENAL GLAND

The adrenal glands lie at the superior pole of the kidneys. They are half moon shaped, Stroma covered by a capsule of dense connective tissue

The capsule sends thin septa to the interior of the gland as trabeculae.

There is a network of reticular fibers that supports the secretory cells and small vessels.



Parenchyma:

It has two layers: Adrenal cortex and adrenal medulla

Adrenal cortex :

It can be divided into 3 layers:

-Zona glomerulosa.

-Zona fasciculata.

- Zona reticularis

The zona glomerulosa:

The cells are columnar, arranged in groups, surrounded by capillaries.

The aldosterone is the most important; acting on distal renal tubule (D.C.T.) Stimulating the absorption of sodium.

The zona fasciculate: the middle zone, Its cells are arranged in straight cords, one or two cells thick. and have capillaries between the straight cords.

The cytoplasm basophilic, shows numerous lipid droplets, so cells appear vacuolated, hence they are called spongiocytes.

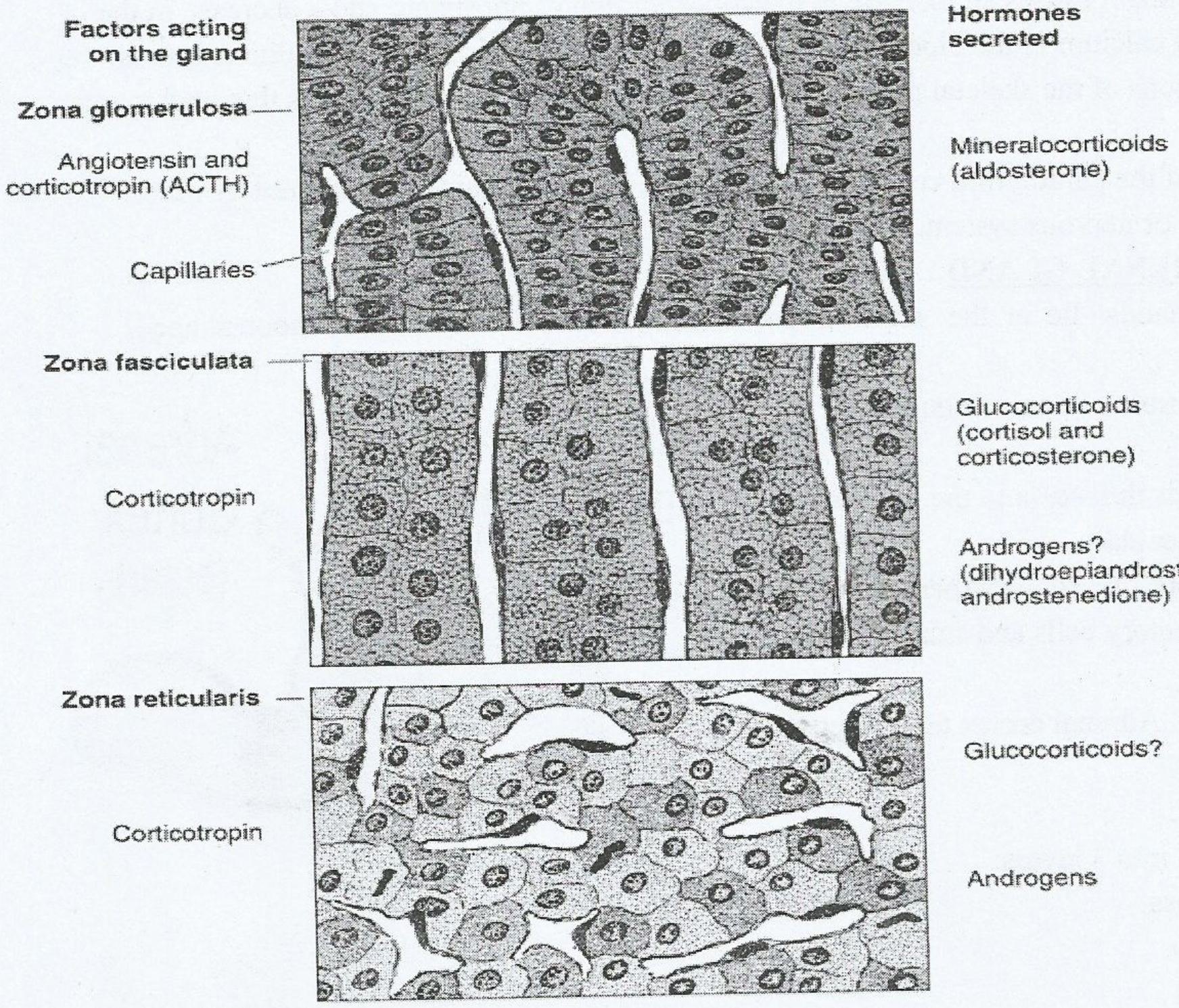
This zone secrete Glucocorticoids. Cortisone and hydrocortisone also suppress the immune response by inhibiting mitosis in lymphoid tissues, reducing circulating lymphocytes number, and decreasing the number of eosinophil

The zona reticularis:the inner one. Lies between The zona fasciculata and the medulla. The cells are disposed in irregular cords that forms an anastomosing network. androgens secretion

-Cells of the adrenal cortex do not store their products in granules; they synthesize and secrete steroid hormones only on demand.

The adrenal medulla: composed by cells arranged in cords or clumps. these cells are termed chromaffin cell have many membrane-limited granules that contains epinephrine or norepinephrine . The epinephrine and norepinephrine are secreted in large quantities only in response to intense

emotional reaction. Capillaries present between adjacent cords. Some parasympathetic ganglion cells are also present



The **islets of Langerhans** appear as rounded groups of cells within the exocrine pancreatic acini. Most islets have several hundred cells and there are more than one million islets in the human pancreas.

In each islet cells are arranged in cords separated by fenestrated blood capillaries. A fine capsule of reticular fibers surrounds each islet. There are five (5) types of cells: A, B, C, D and F. They are also known as α, β, clear for the "C"

The "A" cells: contain the hormone: Glucagon. Glucagon acts on several tissues to make energy. In liver it causes breakdown of glycogen. Increases blood sugar level.

The "B" cells: are most numerous. They secrete the hormone insulin that causes the storage of excess nutrient. The major target organs for insulin are the liver, muscle

The "C" cells:its function is not well known. Could be a resting cell.

The "D" cells: Somatostatin hormone for inhibiting the secretion of growth hormone

The "F" cells: causes relaxation of the gallbladder and decrease bile secretion

مركز الفرقان للخدمات الطلابية

HISTOLOGY

2015

مركز الشامل/ ٤٧ ، ٧٣٣٣٧٧٧ ـ ٤٥ ، ٧٧١٨٨٨٣